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THE INFLUENCE OF THE SERUM PROTEIN ON THE MOTILITY OF THE SMALL INTESTINE

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IN two previous papers (1, 3) we have shown that the emptying time of the stomach of man and dog is markedly prolonged in the presence of a definite hypoproteinemia. In the dog the retardation of gastric emptying time occurred in the intact stomach and after various gastric short-circuiting operations, while in man we have studied this mechanism only in the presence of a gastric or duodenal lesion, and after gastric operations. In our studies the gastric emptying time varied inversely with the level of plasma protein. The implications of this relationship in surgical patients have been pointed out (5). The picture of obstruction in a patient who has recently undergone a gastric operation of the Billroth I or II type may be so striking as to suggest a mechanical defect, at the site of the new stoma, requiring a secondary operation, when in reality efforts directed toward a restoration of a normal serum protein level are more efficacious and not attended by so high a risk.

In the present study, we have studied the effect of hypoproteinemia on the small intestine. The methods employed were similar to those reported in our previous papers. The plasma recovered by plasmapheresis was lyophilized by the method of Flosdorf and Mudd and retained under sterile conditions for intravenous infusion when it was desired to restore a normal serum protein concentration. The dogs were kept, for varying lengths of time, on a diet containing less than 1 per cent protein, but entirely adequate in every other respect including the known vitamins. In addition the animals were subjected to a variable number of plasmaphereses. Serum protein determinations were made upon each animal at frequent intervals. Gastro-intestinal studies were made at weekly intervals after the administration of a water-barium meal. The passage of barium through the small intestine was studied fluoroscopically and radiographically. Since the emptying of the small intestine was, in part at least, dependent on the emptying of the stomach, it was necessary to adopt some more independent index of motility. It was decided to take as an index of small intestinal motility the length of time required for barium to reach the cecum once a bolus had passed through the pylorus.

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Dr. Thompson, Eli Lilly Fellow in Surgical Research.

RESULTS

The first group of dogs was studied over a long period of time during which the blood proteins were reduced chiefly by diet. In each

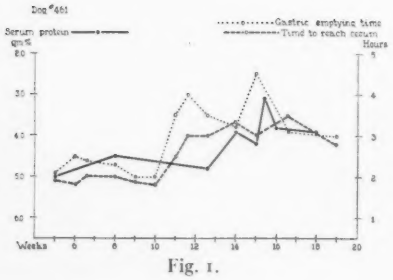

Fig. 1.

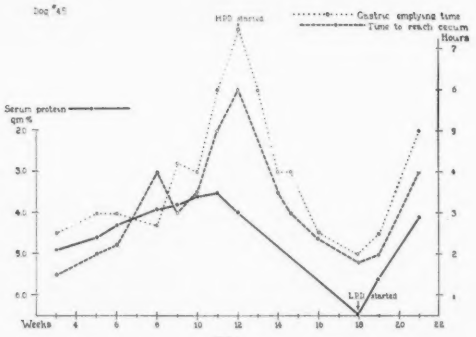

Fig. 2.

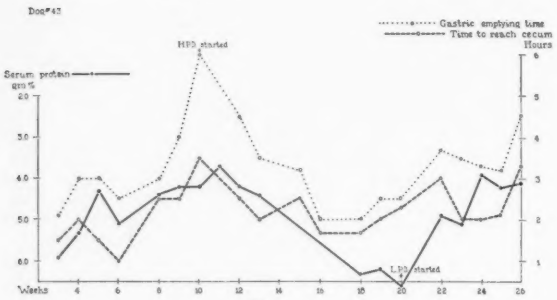

Fig. 3.

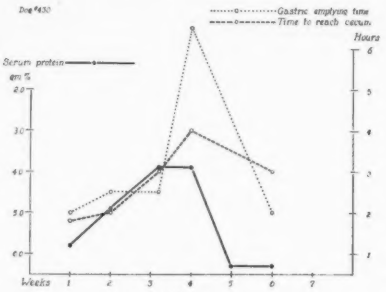

Fig. 4.

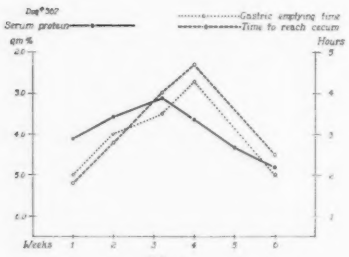

Fig 5.

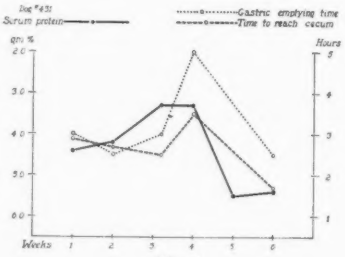

Fig. 6.

Figs. 1 to 6. Relationship between the serum proteins, the gastric emptying time, and the small intestinal motility. *H.P.D*—high protein diet. *L.P.D*—low protein diet.

instance, the gastric emptying time behaved as we had been led to expect from our previous studies. The charts, Figures 1, 2, and 3, compare the serum protein concentration with the gastric emptying time, and time necessary for a barium meal to reach the cecum. It was found that on a protracted low protein diet, the animals lost weight, at times developed ulcers, and were prone to lose their hair. This occurred even though adequate amounts of vitamin A and the B complex were present in the diet.

In order to eliminate the effect of an unrecognized dietary factor at work over a long period of protein restriction, a second group of dogs was rapidly rendered hypoproteinemic. This was accomplished largely by repeated plasmaphereses, although the animals were placed on the low protein diet. Figures 4, 5, and 6 demonstrate the same constant relationship between the serum proteins and the small intestinal motility. Unlike the previous group, these dogs were in excellent condition throughout the period of the experiment.

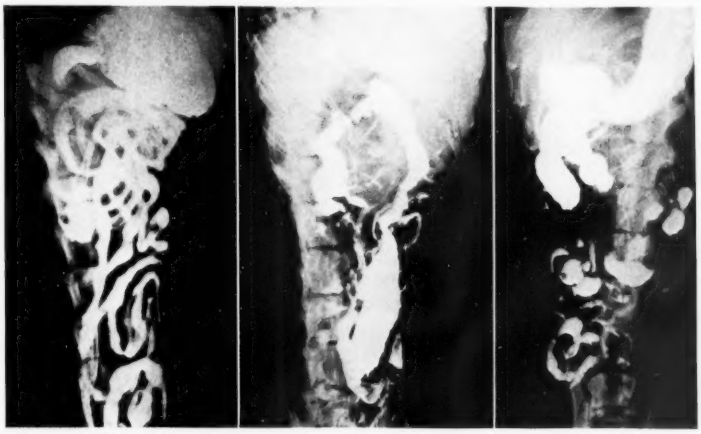

Fig. 7. Fig. 8. Fig. 9.

Fig. 7. Small intestinal pattern—water-barium meal in a normal dog.
Fig. 8. Small intestinal pattern—after water-barium meal in animal which has become hypoproteinemic.
Fig. 9. Small intestinal pattern—water-barium meal in an animal showing nutritional edema.

In the first group, when the hypoproteinemic animals were placed upon a high protein diet, the gastric emptying and small intestinal motility quickly returned to normal. In the second group of animals, the same effect was produced by transfusions of the plasma which had been removed during the plasmapheresis.

The tissue edema which was shown to be chiefly responsible for the delay in gastric emptying time in our earlier experiments is, we believe, the chief factor in producing the retardation in motility of the small intestine.

During the present study it was found that the pattern of the barium-filled small intestine became quite bizarre and abnormal as the concentration of the serum proteins fell, and that this pattern was a reflection of the altered physiology in the small intestine, associated with the hypoproteinemic state. This observation merely emphasizes the importance of the small intestinal pattern as a reflection of systemic disease, a relationship which has been discussed in several recent papers (4, 6). Figures 7, 8, and 9 show this change as it occurred in one of our animals.

CONCLUSION

The present paper extends our former study of the relation of serum protein concentrations to gastro-intestinal activity. It has been demonstrated that a reduction in the concentration of the serum proteins is associated with a marked retardation of the passage of a water-barium meal through the small intestine of the dog. Concomitant with this physiological change there is an anatomical change, as evidenced by the change in the intestinal pattern. Both these alterations from the normal can be corrected by restoring the serum protein to a normal level either by diet or transfusions of lyophilized plasma.

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NON-INVASIVE POTENTIAL "CARCINOMA" OF THE CERVIX

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A STUDY of the most recent and best results of radiative and operative treatment of cervical cancer shows that, by and large, not more than one-quarter of the cases are cured. Statistics reveal that cancer is the second most frequent cause of death in the Western World and that carcinoma of the uterus is responsible for about one-third of the deaths from cancer in women.

In approximately 90 per cent of these cases it arises in the portio of the cervix, an organ which, like the tongue, skin, and penis, can be not only readily seen but also carefully scrutinized in a few minutes during the course of a routine physical examination. As has been reiterated, the operative and radiative types of therapy for this kind of carcinoma have about reached their peak of development and give no promise of any great further advancement in the near future. The most favorable statistics show that in those cases in which the cancer is still definitely limited to the cervix at the time radiative therapy is instituted about 52 per cent (Ward and Sackett) may gain a 5 year cure. This is accomplished only with frequent and careful check on their progress and with further radiation when required.

The average for several similar groups of cases given surgical treatment or combinations of both forms gives about a 50 per cent cure. In advanced cases one-fifth or less are alive after 5 years (30, 25). The inference from this is, as Celsus is credited with having pointed out about 30 A.D., that the earlier in the course of the disease the diagnosis can be made the better the chance for cure. With the view of trying to assemble and study as large a group of early carcinomas as possible, this work was undertaken.

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HISTORICAL

Cancer research was first centered upon the question of etiology, but none could be found comparable to the specific causal relationship of the gonococcus to gonorrhea. Research then turned, especially with those working on cervical carcinoma, to a study of the symptoms, and soon the asymptomatic phase was realized. The study of this, like that of prevention, brought investigators to consider the earliest forms of cancer.

The first mention of the general type of early cervical carcinoma with which this paper is concerned is found in the large work on carcinoma of the uterus by Schottlaender and Kermauner which was published in 1912. They noted the presence of a thin layer of surface carcinoma extending over the portio from the edge of a larger invasive growth. It completely replaced the normal epithelium, and was compared morphologically to the icing on a cake. These two workers considered it to be definite carcinoma and described its cells as being exactly similar to those of the main deep growth. They also mentioned its usual abrupt ending and junction with the normal stratified squamous epithelium of the portio. About 15 years ago, Schiller, who had worked under Kermauner, began concentrated work on the genesis of tumors, and chose the cervix as his medium because of its accessibility and the frequency with which carcinoma develops there.

In his first paper on this subject, published in 1927 (18), he points out the evidence against cervical carcinoma being caused by irritation. He describes what he calls "beginning carcinoma" of the cervix, and states that it consists of a non-invasive anaplastic epithelial growth usually located at the external os. Since the morphological characteristics of the cells are like those of the cells comprising an advanced carcinoma he designates these early non-invasive lesions uncon-

ditionally as carcinoma. He also describes in detail the sharp and usually oblique border between the carcinoma and normal squamous epithelium, and mentions the frequent presence of vacuoles in those normal cells which are closely adjacent to the carcinomatous ones. He could find no evidence of precancerous cellular alteration, or of carcinoma in definite connection with erosion or repair. In the development of cancer he considers two changes: that of the surface epithelium into carcinoma, and, after a period, its invasion of the stroma. He describes the light superficial lymphocytic infiltration of the stroma beneath the surface carcinoma and believes it to be evidence of the conflict between the two types of tissue, the cancer cells, and those of the connective tissue. He believes that the normal cells lying immediately adjacent to the carcinomatous ones change very suddenly to cancer cells due to a "complete assimilatory metabolic change" resulting from the influence of the adjoining malignant cells. He feels that this change is irreversible and so rapid that no intermediary morphological stages are to be seen. General pathological opinion both here and in Europe does not completely support these hypotheses.

Schiller believes that metastasis may take place as soon as invasion has begun, and that all carcinomas, whether invasive or not, should receive radical treatment.

Contrary to Lahm's work, Schiller was unable to find *any* glycogen in carcinoma cells and so tried various stains with which to bring out this difference grossly. He finally was able to obtain good results using a weak aqueous iodine and potassium iodide solution (19). He points out (23) that although grossly these areas often differ little or none from the normal epithelium of the portio they are sometimes dull, white, opaque, and slightly wrinkled. In serial sections of cervices from 425 panhysterectomies, Schiller found 6 incipient "carcinomas," an occurrence of 1.41 per cent.

The American literature covering the pathology of this type of early carcinoma of the cervix is rather meager. One of the first reported cases of early carcinoma was that of Cullen in 1921 (2). A few of the recent notable papers in this group are those of Novak (13, 14), Martzloff (9, 10), Norris, Broders, Pemberton and Smith (16, 17), TeLinde, Freedman, and Henriksen (5). Novak, Martzloff, and some others have held the view that as long as the intra-epithelial changes are not invasive, the lesion is not malignant, and since it is not malignant it cannot be called "cancer." On the other hand Graves, Smith and Pemberton, Broders, and some others have agreed with Schiller, believing that these growths are cancer as soon as the cells have assumed the morphological characteristics common to all cancer cells. Thus we find that pathologists are divided upon the questions as to whether these non-invasive lesions inevitably become invasive and as to whether they can legitimately be called cancer.

GENERAL DISCUSSION

The studies, begun by Schottlaender and Kermauner and carried on by Schiller, on early carcinoma of the cervix have been a great contribution and have called the attention of the medical world to this important pathological condition. There are many, as was previously stated, who do not agree with Schiller in his calling non-invasive growths definite cancer. Lubarsch, Frank, Menne, MacCallum, Novak (13), Martzloff (9), and others disagree with him on this point. However they do believe that these lesions are in some way related to carcinoma and may develop into the invasive destroying growth commonly recognized as cancer. It is their view that without heterotopia these lesions cannot be looked upon as cancer, as the inherent connotation and original meaning of this word is "an invasive destroying growth." In favor of their side of the question is the fact that the word "cancer" was used long before the individual characteristics of malignant cells were known. In addition, although "carcinoma" is a more recent term it has always been used synonymously with "cancer" when the growth was composed of malignant epithelial cells.

One of us (C.S.S.) also agrees with the viewpoint that these non-invasive lesions definitely may become typical, destructive and invasive cancers, and suggests that they be called "non-invasive potential carcinomas"

Fig. 1.

Fig. 1. Case 2 (Gyn. Path. 25171). The lesion is essentially limited to the squamous epithelium to the left of the gland mouth, *A*. The sharply cut edge of the "carcinoma" at the extreme left has curled inwardly, probably in the fixing solution. ×25.

Fig. 2.

Fig. 2. Case 2 (Gyn. Path. 25171). The nearly complete absence of stratification, the intact basal layer of cells, and the closely packed large anaplastic epithelial cells denote the lesion. ×75.

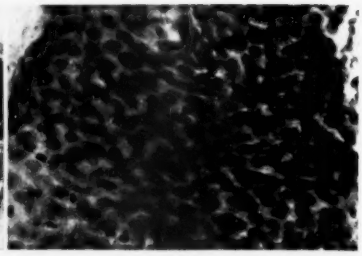

Fig. 3.

Fig. 3. Case 2 (Gyn. Path. 25171). Despite the thickness of the section some large "black" nuclei can be seen with much smaller light staining ones nearby. At the upper left corner the most superficial cells are seen to contain large very darkly stained nuclei. ×300.

of the cervix. The large invasive carcinomas which developed, as will be described, in two of our cases following the biopsy which showed them in their non-invasive but potential state, coupled with the few other similar known cases, are evidences in favor of this view.

The other writer of this article (E. S. Jr.) believes, with Schiller and his adherents, that the presence of the malignant morphological characteristics in the individual cells comprising these lesions is sufficient for the unqualified pathological diagnosis of carcinoma of the cervix, the presence or absence of invasion being of no practical diagnostic importance. The fact that many cervices, from which the original biopsy contained a non-invasive "carcinoma," on serial sectioning show a few small tongues of invasion, points, he believes, to the danger of not calling them carcinoma. These two viewpoints are illustrative of the differences of opinion among various workers on cancer problems.

METHOD

On the basis of the present knowledge of this subject, we recently undertook to examine all the cervical tissue in the files of the Gynecological Pathology Laboratory of the Johns Hopkins Hospital. We carefully studied some ten thousand microscopic sections of cervical

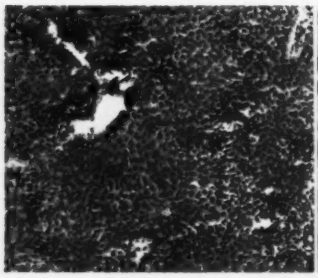

Fig. 4.

Fig. 4. Case 2 (Kelly Hospital Path. 13414). This is a typical section of the large invasive carcinoma which developed after 8 years, apparently from remains of non-invasive potential "carcinoma" pictured in Figures 1, 2, and 3. ×65.

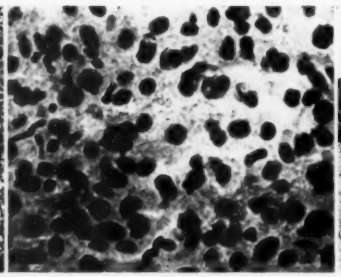

Fig. 5.

Fig. 5. Case 2 (Kelly Hosp. Path. 13414). High power detail of the carcinoma in Figure 4. Note the large round and oval darkly stained nuclei similar to those in Figure 3. ×265.

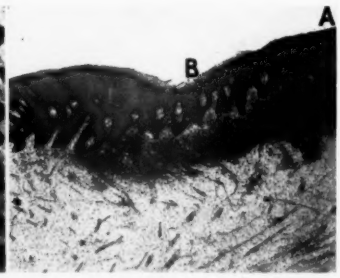

Fig. 6.

Fig. 6. Case 3 (Gyn. Path. 26010). The "carcinoma" extends through *A* to *B* and is separated from the normal squamous epithelium by a fairly sharp border. Of chief interest in this section is the dense localized infiltration of lymphocytes in the stroma which are present just beneath the lesion and which extend a short distance laterally beyond it. ×18.

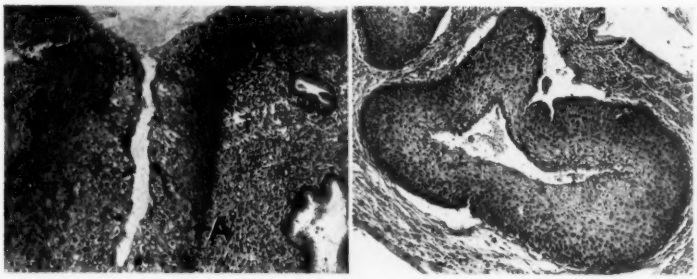

Fig. 7, left. Case 4 (Gyn. Path. 27258). The "carcinoma" here has grown down into and lined a gland. The portion which covers the surface (upper right) is thinned out apparently due to the fact that the superficial spinal cells have been eroded away. In the gland they are intact and compose the major portion of the growth. A few of the spinal cells are multinucleated; the one at *A* is seen to contain 5 nuclei under the microscope. The basement membrane of the gland and the layer of basal cells of the "carcinoma" are intact. ×55.

Fig. 8. Case 7 (Gyn. Path. 30818). The "carcinoma" has grown into and lined a superficial gland. As in Figure 7 the superficial spinal cells remain intact and make up a large portion of the growth. Some fairly large hyperchromatic nuclei can be found in the superficial cells. ×50.

tissue from about four thousand cases, picking from them all those which had any suggestion of epithelial hyperactivity or anaplasia exclusive of the cases which showed invasive carcinoma. We then separated these into two groups, those in which the cells showed definite carcinomatous change and those in which we believed the epithelium to be merely hyperactive. As a result we had a few sections which appeared to show non-invasive "early carcinoma." Realizing, as Schottlaender, Kermauner, and Schiller have pointed out, that any of these might be merely the surface edge of a large advanced carcinoma, we looked through our files for any further pathological material on these patients. As a result of this we found that several of the biopsies had come from the external os and had contained part of an outer extension from a larger carcinoma situated up in the cervical canal, or that they were taken from the edge of a small ulceration on the portio, which on shortly repeated

Fig. 9.

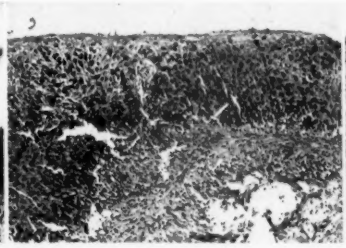

Fig. 10.

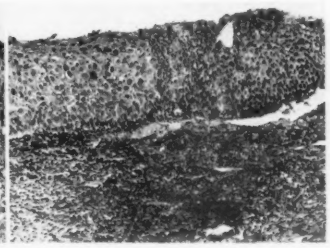

Fig. 11.

Fig. 9. Case 12 (Gyn. Path. 40282). This is a relatively high power photomicrograph showing the detail of a typical oblique border between the "carcinoma" (on the right) and the normal stratified squamous epithelium (on the left). The hyperchromatosis of the lesion is marked and causes it to stand out sharply from the adjacent normal cells. The border is much more oblique than usual; the superficial part begins at *A* and the basal part extends far laterally under the normal epithelium to *B*. A large mitotic figure is seen at *C*. ×95.

Fig. 10. Case 13 (Gyn. Path. 40900). The lesion is characterized chiefly by the large variously shaped dark staining nuclei scattered among many similar sized or smaller light staining ones. A few of the superficial nuclei are large and darkly stained. ×55.

Fig. 11. Case 13 (Gyn. Path. 41429). This is another biopsy section, taken 5 months after that shown in Figure 10. The general appearance is similar to that of the biopsy specimen taken from the same patient 5 months previously, the same "level" of activity being present. ×55.

Fig. 12.

Fig. 13.

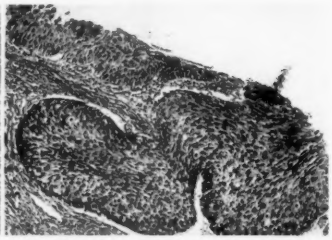

Fig. 14.

Fig. 12. Case 13 (Gyn. Path. 45520). This section is through the anterior lip of the cervix. The "carcinoma" covers the entire portio, extending from the general region of the external os (lower right corner) out over the surface almost to the vaginal wall (upper left corner). No points of invasion are seen. ×20.

Fig. 13. Case 13 (Gyn. Path. 45520). This is a typical part of the superficial "carcinoma" which covers the portio of both the anterior and posterior lips of the cervix. This field was taken from a point 2 millimeters from the area shown in Figure 14. This "carcinoma," when compared to those in Figures 10 and 11, is seen to bear a striking resemblance to the lesions found in these biopsy specimens taken 2½ and 3 years previously from the same cervix. ×70.

Fig. 14. Case 13 (Gyn. Path. 45520). This field is from the posterior lip of the cervix and is in the same section as the field shown in Figure 13. The surface (upper left) is covered with somewhat inactive and eroded superficial "carcinoma." There is a fairly large tongue of quite active carcinoma growing into the stroma from the surface. Its component cells show not only the anaplastic characteristics of those in the original surface lesion but in addition there are many mitoses and the hyperchromatosis is more marked. ×70.

biopsy had been proved a moderately advanced carcinoma. Several cases were apparently bona fide non-invasive "carcinomas," but had to be discarded when careful serial sectioning of the rest of the cervical tissue disclosed a few small tongues of early invasion. Thus, after submitting each case to an impartial study, only 18 remained which we could definitely classify as "non-invasive" carcinoma of the cervix. All of our diagnoses were very kindly checked and confirmed by Dr. Walter Schiller and Dr. Emil Novak.

Brief histories of the 18 cases follow with pathological description when important.

Case 1. (Path. 23771) F. L., aged 57 years. Patient had one child at 45, preceded by three spontaneous abortions. She was seen on February 21, 1918, and complained of complete uterine prolapse

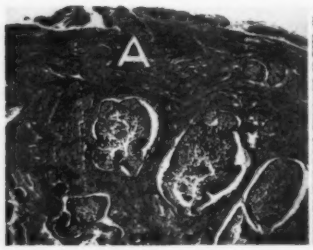

Fig. 15.

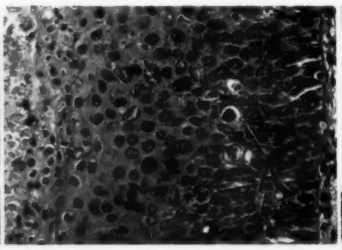

Fig. 16.

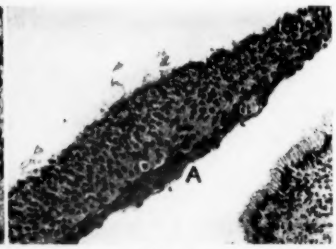

Fig. 17.

Fig. 15. Case 13 (Gyn. Path. 45520). This is another section through the posterior lip. It shows the "carcinoma" covering the surface like "icing on a cake," and at one point *A* there is an invading tongue of actual carcinoma. The stroma contains several circumscribed masses of the growth which are identical in appearance with the tongue seen in Figure 14. In them the transitional cell predominates although the borders are composed of several layers of spindle cells. ×16.

Fig. 16. Case 16 (Gyn. Path. 44092). This photograph includes the entire thickness of a non-invasive "carcinoma" with the intact basal layer on the extreme right and the roughened surface on the extreme left. Five mitoses are denoted by *A*. The variations in the size, shape, and staining density of the nuclei is rather marked. There is practically no erosion of the surface as the atrophic spinal cells are still present and even their black pycnotic nuclei show more than the usual variation in size and shape. ×190.

Fig. 17. Case 18 (Gyn. Path. 45133). The "carcinoma" here has been stripped away from its stroma, and by some artefact of fixing or sectioning, rotated so as to face an adjacent portion of the cervix (lower right). The large variously shaped extremely dark staining nuclei are very prominent and some of them are present in the most superficial cells, *A*. This finding is one nearly infallible characteristic of non-invasive potential carcinoma. ×95.

for the last 6 months. She had worn a pessary for 2 years previous to this. Examination showed lacerations of the perineum and complete uterine prolapse. A trachelorrhaphy (Emmett), anterior and posterior colporrhaphy, and Wertheim suspension of the uterus were done. Pre-operative examination of the cervix had shown that it was slightly enlarged and edematous and that the portio was smooth and pink despite moderately deep transverse lacerations. The microscopic section from one trachelorrhaphy specimen (this V-shaped wedge is usually taken so as to include all of the laceration) shows a rather large block of tissue which has obviously been trimmed down. At one end of it a superficial gland opens to the surface, and around its mouth there is a very small localized non-invasive "carcinoma." Its cells are generally large and they show a marked variation in size and shape. Many, both large and small, are very deeply stained. Similarly, many are lightly stained regardless of size. The surface is slightly eroded, and the usual superficial, flat, atrophic spinal cells, in which the nuclear remains are normally marked by a small dark dot, are replaced by large cells which contain large round or oval nuclei and have rather indefinite cytoplasmic borders. In many instances a cell can be found which has a diameter four times that of its neighbor and their staining densities may be similar or at opposite extremes. The finding of about 12 mitoses per high power field indicates a relatively hyperactive growth. This patient died of hypertension with coronary thrombosis in November, 1935, at the age of 74 years. Either all of the growth was removed or that which remained did not become a cancer over a period of 17 years.

CASE 2. (Path. 25171, K-13414). C. P., aged 28 years when first seen June 30, 1919. She had had 4 children and was "badly torn" with the last one 3 years before. She came in because of "bearing down pains" since the birth of her last baby, leucorrhea for the past year, and occasional slight spotty intermenstrual vaginal bleeding for this same period. Examination showed a relaxed vaginal outlet, rectocele, and lacerations of the cervix. She then had a trachelorrhaphy, posterior colporrhaphy, and appendectomy. Pre-operative examination showed the cervix to be enlarged, firmer than usual, and slightly elongated. It pointed in the vaginal axis due to retroposition of the uterus. There were deep transverse lacerations, more so on the left, and there was moderate eversion on both lips around the external os. The portio was smooth and clean. The microscopic section from one trachelorrhaphy specimen shows a junction of the cylindrical cervical epithelium and the squamous type on one surface. As Figure 1 shows, the carcinomatous cells are limited to a point on one side of the mouth of a large cervical gland, and there is the afore mentioned junction on the other side. The "carcinoma" is 0.5 millimeter long and its left edge is sharply cut off. This is either the result of trimming the block, or, since it looks as though it has curled in, may well be the edge of the specimen as removed at operation. One thus might conclude that the non-invasive potential carcinoma extended out over the portio and all of it was not removed. The higher power microscopic detail is about the same as that in Case 1, and a rough idea of it can be obtained from Figures 2 and 3. Unhappily the section is a thick one and the photographs are not what they might be. The variations in nuclear sizes, shapes and staining densities are of average degree except that hyperchromatosis is rather marked in a few cells. There is no definite spindle-shaped basal cell, the round or oval nucleated transitional type comprising nearly the entire thickness of the epithelium. Consequently, despite a few flattened superficial cells, there is a rather marked absence of stratification. The presence of about 8 mitoses per high power field indicates that it is a fairly hyperactive growth.

This patient next came to the hospital May 4, 1921, complaining of leucorrhea, backache, and profuse menstruation. At this time the cervix was smooth, firm, nearly flush with the vaginal vault, and there was a profuse leucorrhea exuding from the external os. A large ovarian retention cyst was found and removed. The cervix was not treated.

On February 28, 1928, she came to the hospital again complaining of continuous vaginal bleeding since the onset of her last recognizable menstrual period 4 months before. Examination disclosed a large cauliflower-like tumor replacing the cervix and filling the vaginal vault. It was friable, firm, and bled upon manipulation. There was thickening and induration of the vaginal vault and both broad ligaments half way laterally to the pelvic wall. In spite of radium treatment she died in a little over a year. A biopsy of this tumor (slide K-13414) shows several pieces of tissue made up of irregular large solid masses and thick columns of anaplastic epithelial cells (Fig. 4). These cells have predominantly large, round to oval nuclei which show all the variations seen in the original non-invasive growth. A high power field gives a picture (Fig. 5) generally similar with that of the earlier carcinoma, as a comparison of the two photomicrographs will disclose. The diagnosis here was "epidermoid carcinoma of the cervix, transitional cell type." Since the transitional type of cell predominated in both growths it may indicate that the relative degree of cell differentiation in the original anaplastic cells has not changed with invasion.

CASE 3. (Path. 26010). M. M., aged 38. She had had one child and came to the hospital June 3, 1920, complaining of leucorrhea, backache, complete prolapse of the uterus for 3 years, and metrorrhagia for 5 weeks. Examination showed obesity and third degree uterine descensus. She had a conservative panhysterectomy and left oophorectomy. Pre-operative examination of the cervix showed it to be twice normal size, edematous, and tender. It was moderately deeply lacerated transversely and was eroded around the external os. A microscopic slide shows a cross section through one lip of the entire cervix. There is a non-invasive potential "carcinoma" which begins at

the external os and extends out over the lip for 8 millimeters. As Figure 6 poorly demonstrates, the anaplastic cellular changes are marked, the basal layer is intact, and there is the usual oblique border. In addition there is a strikingly dense superficial infiltration of lymphocytes in the stroma, as has been described by Schiller. In typical fashion it extends a short distance beyond the edge of the lesion, and the significance of this may be that the adjacent, as yet non-anaplastic, cells are in some manner under the influence of the "carcinomatous" ones. The fact that they are morphologically normal and do not even show any structural evidences of hyperactivity does not exclude the possible presence of a profound physiological change, and some believe that such might be the case. Unfortunately, all efforts to trace this patient proved fruitless.

CASE 4. (Path. 27258). G. V., aged 46 years, who had had 12 children and two abortions, came to the hospital complaining of severe lower abdominal pain, leucorrhea, and dysuria for 1 month. Examination showed a relaxed vaginal outlet. She had a trachelorrhaphy and an anterior and posterior colporrhaphy. Before operation the cervix was slightly enlarged and irregular, but the portio was relatively smooth. There were very deep transverse lacerations, extending out to the vaginal vault, which bled on examination. A microscopic section of one trachelorrhaphy specimen shows a non-invasive potential "carcinoma" beginning in the laceration exactly at the junction of the columnar and stratified squamous epithelium, and it extends out over the portio for 6 millimeters. The nuclear variations in size, shape, and staining density are very marked (Fig. 7). The basal layer consists of about one layer of spindle cells and is intact. Superficial to this there are about two layers of the characteristically round-nucleated transitional cells. The main epithelial thickness lies superficial to this and is made up of typical spinal cells which have a prominent and relatively large amount of grayish-pink cytoplasm with rather definite cell borders. Their nuclei show marked anaplasia, as already mentioned, and a few very large cells contain 5 and 6 nuclei clumped together in the center. Many mitoses can be found. As Figure 7 shows, these anaplastic cells have grown down into a gland for a short distance. This phenomenon has been described by Novak (13), Schiller, and others, and is no indication of invasion. This woman is alive and well, and many biopsies of the now atrophic cervix have shown no suggestion of malignancy.

CASE 5. (Path. 28559). M. B., aged 50 years, upon being examined in the dispensary on May 2, 1923, was found to have a cervical polyp. It was removed with the biopsy forceps. The microscopic slide shows a section through its entire length. There is a non-invasive potential carcinoma 1 centimeter long on one surface well up and away from the base. It appears to arise about 6 millimeters from the cylindrical squamous cell junction, and is chiefly apparent due to its marked hyperchromatosis. The section is too thick for photography but under the microscope the malignant characteristics of the cells are obvious. The presence of about 16 mitoses per high power field denotes unusual hyperactivity. Some of the mitotic figures are tripolar and many show markedly uneven division of the chromosomes, which, as Mendelsohn and others have pointed out, is characteristic of malignant cells. This woman unfortunately could not be traced.

CASE 6. (Path. 30583). J. S., aged 49 years, a mother of 3 children, came to the hospital on August 21, 1925. She complained of leucorrhea for 1 year and came to the hospital for verification of the diagnosis of "cervical polyp" made by her family physician. Examination revealed a polyp. It was resected and its base and the cervical canal were thoroughly cauterized with 30 per cent silver nitrate. Before operation the cervix had been very firm and normal in size and shape. A full length cross section of the polyp is found in the microscopic slide, and it reveals a non-invasive potential "carcinoma" 1 millimeter long which lies practically at the cylindrical, squamous cell junction and extends down to the cut border at the base of the polyp. The woman is asymptomatic and recent biopsies of the cervix and scrapings from its canal show no evidence of malignancy.

CASE 7. (Path. 30818). M. C., aged 38 years, had had 4 children and 1 abortion, and came to the hospital November 24, 1925, complaining of moderate leucorrhea for 3 years and lower abdominal pain for 6 months. Examination revealed obesity and a relaxed vaginal outlet. A left sided trachelorrhaphy and an anterior vaginal repair were done. Before operation the cervix was described as being about normal in size and consistency, and it was transversely lacerated, more deeply on the left. The microscopic section of the tissue removed from the cervix shows the "carcinoma" to be practically limited to a shallow gland ingrowth (Fig. 8). As can be seen the growth is made up of relatively highly differentiated cells, and roughly consists of equal amounts of transitional and spinal cells. While the lack of cell uniformity is not as striking as in some of the sections, the wide differences in nuclear sizes and shapes are readily apparent. She is alive and well and has no symptoms suggestive of cervical carcinoma. In this case a biposy cannot be obtained, and we may thus assume that if all of the lesion was not removed the remaining portion has not become invasive after twelve years or has in some manner been destroyed.

CASE 8. (Path. 31795). A. B., aged 56 years, a mother of 6 children, had had a hysterectomy 3 years before for uterine fibroids. She came to the hospital November 23, 1926, complaining of leucorrhea for 3 years and slight post-coital bleeding for 3 months. Examination showed the cervix (stump) to be slightly smaller than normal, about 2 centimeters long, and of average consistency. There was some eversion around the external os, and a few slightly roughened, dark red areas of erosion 7 millimeters in diameter were situated on both the anterior and posterior lips.

These bled slightly upon examination. Several biopsies of the portio were taken, the canal of the stump was curetted, and the cervix was thoroughly cauterized with the actual electrocautery. The section of the biopsied tissue contains a great many strips of stratified squamous epithelium and one wonders if any was left on the portio. The non-invasive potential "carcinoma" is limited to two of these strips, which, due to the hyperchromatosis, stand out sharply from the neighboring normal epithelium. This woman died of apoplexy at the age of 64, by which time she had not developed a gross clinical cervical carcinoma. If the growth was not either all removed or destroyed at the time of operation that which remained was non-invasive for 8 years at least.

CASE 9. (Path. 33968). C. B., aged 34 years, a mother of two children, came to the hospital November 16, 1928, complaining of menorrhagia for 5 months and metrorrhagia for 2. Examination showed retroposition of the uterus and relaxation of the vaginal outlet. A trachelorrhaphy, anterior and posterior colporrhaphy, and suspension of the uterus were done. Pre-operative examination showed the cervix to be normal in size and consistency and slightly lacerated transversely. The microscopic slide of the trachelorrhaphy specimen contains several fragments of cervical tissue, 2 of which are partly covered by non-invasive "carcinoma." This patient is alive and well and has no symptoms of carcinoma of the cervix. A biopsy of the cervix cannot be obtained.

CASE 10. (Path. 35546 and 35573). H. C., aged 34 years, a negress who claimed she had never been pregnant, and who had had gonorrhea recurring off and on since the age of 18, came to the dispensary February 11, 1930, complaining of menorrhagia for 1 year. She was found to have a large myomatous uterus and chronic salpingitis and had a hysterectomy and bilateral salpingectomy. Shortly after discharge the cervix was found to be slightly enlarged, soft, and roughened. There was some erosion of the portio around the os which bled following examination; there were superficial transverse lacerations. Several biopsy specimens were taken from the lacerations and the eroded areas. The microscopic section shows some semicircular fragments of cervical tissue, one of which is covered with a non-invasive potential "carcinoma." The nuclear variations are marked and there is some fairly obvious hyperchromatosis. The patient was given radium and is alive and well, and a small scarred nodule in the now contracted vaginal vault is all that marks the former location of the cervix. A biopsy shows only scar tissue covered with a very thin layer of markedly atrophic squamous epithelium.

CASE 11. (Path. 35996). E. W., a 27 year old mother of 5 children, came to the hospital July 7, 1930, complaining of post-coital bleeding for 1 month. The cervix was of about normal size and shape, but was softer than usual. There was "a reddened area on the anterior lip" from which several biopsy specimens were taken. Under the microscope one of the several fragments was found to be covered with a non-invasive "carcinoma." This patient was alive and well and without any symptoms of cervical carcinoma in July, 1936. She has never received any treatment for the lesion and at present cannot be located.

CASE 12. (Path. 40282). D. B., a 61 year old mother of 5 children, came to the hospital November 2, 1933, complaining of complete uterine descensus for 5 months. She had a Watkins interposition operation and a low cervical amputation. Before operation the cervix was found to be small, softer than normal, and bilaterally lacerated. The portio was smooth and there was slight eversion around the os. The microscopic slide includes a full sized section from each lip of the cervix. On one lip, for a distance of 1 millimeter, there is a non-invasive potential "carcinoma" which, due to its marked anaplasia, stands out sharply from the adjacent benign epithelium. At one edge (Fig. 9) there is a typical sharp oblique border. The "carcinoma" shows an extreme degree of hyperactivity, there being about 27 mitoses per high power field over one area. This woman is alive and well, and the cervical stump looks normal. Biopsies from it and scrapings from the canal show no evidence of malignancy.

CASE 13. (Path. 40900, 41429, and 45520). M. S., a 34 year old mentally retarded woman who had had 2 abortions, came to the hospital July 31, 1934, complaining of dyspareunia of 2 years' duration. She had contracted gonorrhea at the age of 21 years, following which she had had a bilateral salpingo-oophorectomy with its subsequent surgical menopause. The cervix was found to be small and of normal consistency. There were deep transverse lacerations, and the portio was otherwise smooth and normal except for a slight perioral reddening. Several biopsies were taken around the os. The microscopic slide of these shows two fragments of cervical tissue, the surface of one being partially covered by a non-invasive potential "carcinoma" (Fig. 10) which totals 3 millimeters in length. The cells show an average amount of malignant anaplasia manifested chiefly by the wide variations in nuclear sizes and shapes. The variations of staining density are of average diversity and there is a moderate amount of hyperchromatosis. The growth looks very inactive and only one mitotic figure can be found. There is a moderate infiltration of lymphocytes in the stroma beneath the lesion. At that time the slide was considered suspicious but the patient refused to allow further biopsy and left the hospital. She returned January 8, 1935, complaining of lower abdominal pain. The cervix was found to be as it was 5 months previously except that now the portio was smooth and normally pink. Biopsy specimens were again obtained from the cervix and the canal was curetted, but the scraping produced no tissue. Under the microscope the fragments of cervical tissue were found to be normal except that the surface of one of them was covered with a 4 millimeter length of non-invasive potential "carcinoma." A small piece of

stroma remained attached to it and was infiltrated with lymphocytes (Fig. 11). The anaplasia of the cells was marked and the general picture was identical with that seen 5 months previously. The same activity "level" prevailed as no mitoses could be found.

This woman again refused any treatment and returned to her home in one of the Southern states. When we finally located her she was extremely ill with pernicious anemia but was without any symptoms of cervical cancer. She died of the anemia July 15, 1937, and we were very fortunate to obtain the cervix for pathological study. Grossly it was normal in size, shape, and consistency, and the portio appeared to be smooth and shiny to the unaided eye. On section it showed nothing unusual. It was cut serially into blocks from each of which microscopic sections were made. One of these (Fig. 12) showed the anterior lip of the cervix to be nearly entirely covered, even out to the vaginal vault, with non-invasive "carcinoma." A section from the posterior lip (Fig. 13) showed the non-invasive "carcinoma" again covering the portio, but here (Fig. 14) there was also a tongue of apparently fresh invasion extending from it into the stroma. The non-invasive portion on the surface (Fig. 13) was identical in appearance with the biopsy specimen taken 3 years (Fig. 10) and 2½ years (Fig. 11) previous to the patient's death, and it likewise shows no mitoses. In contrast the cells comprising the invasive tongue are larger, more "active" in appearance, and quite a few mitoses are readily found. Other sections through the posterior lip of the cervix show somewhat similar tongues of invasion, and in addition the body of the cervix contains many bundles of the same carcinoma (Fig. 15). Thus we have a case of asymptomatic carcinoma of the cervix in which invasion from the pre-existent, non-invasive lesion probably began an estimated 2 to 4 months before the death of the patient. Unfortunately, an autopsy could not be done on this case, and we do not know if there were any metastases or extensions of the growth into the parametrial tissue. It is the opinion of her attending physicians that her death was due entirely to refractory pernicious anemia.

CASE 14. (Path. 42430). N. I., a 52 year old mother of two children, came to the hospital complaining of joint pains for 9 months and was found to have infectious arthritis. She was referred to the gynecology department for a pelvic check-up with regard to a possible focal infection there. Examination showed that the cervix was about normal in size, shape, and consistency. The anterior lip was smooth but the posterior lip was slightly adherent to the posterior vaginal wall, and these adhesions were injected and bled slightly following examination. Biopsy specimens were taken from both lips. The microscopic section showed two fragments of cervical tissue one of which was covered on one side with normal stratified squamous epithelium and a very short length of thin non-invasive "carcinoma." This patient was given radium directly to the portio and is alive and well. Recent examination has shown no evidence of cervical carcinoma.

CASE 15. (Path. 43321, 43366, and 43381). L. C., a 46 year old Russian Hebrew woman who had had one child and two abortions, came to the hospital May 6, 1936, complaining of metrorrhagia for 3 days 1 month before. She had had a subtotal hysterectomy at the age of 25 years, and she had not menstruated since. Examination disclosed obesity, a hypertension of 220/150, and diabetes. The cervical stump was found to be small, of normal shape and consistency, and the portio was smooth except for a small circumscribed eroded area on the posterior lip which bled on examination. Several biopsy fragments were taken from the cervix, and the microscopic slide contained several of these fragments of cervical tissue and a few small fragments of non-invasive potential "carcinoma." She was given radium and was alive and well when last heard of in December, 1936. Further attempts to locate her have proved fruitless.

CASE 16. (Path. 44092). J. S., a 62 year old nulliparous married Hebrew woman, came to the hospital November 5, 1936, complaining of very slight metrorrhagia for 8 months. On examination the cervix was found to be small, firm, of normal nulliparous contour, and the portio was smooth except for several small areas of erosion on both the anterior and posterior lips. Several biopsy fragments of tissue were taken. The microscopic slide showed some fragments of cervical tissue and a strip of typical early non-invasive potential "carcinoma" 3 millimeters long. As can be seen in Figure 16 the anaplasia is very marked. The nuclei are greatly varied in shape, size, and staining density. There are 10 mitoses per high power field. The basal layer is intact and consists of about three layers of spindle cells. Then about half of the thickness of the epithelium is made up of round or oval nucleated transitional cells, and superficially these change over and somewhat resemble spinal cells. This latter change consists of a horn-like appearance and increased prominence of the cytoplasm, with the nuclei becoming more generally oval but not decreasing in size. In this particular case there is a thin superficial layer of atrophic cells in which the nuclei are small, usually oval, and take a dense dark stain. In most sections these cells cannot be found as they usually slough off as soon as they become atrophic. The transitional type of cell predominates although there is some semblance of stratification remaining. The mitoses are evenly distributed between the three viable layers, and several are found in cells practically at the surface, which is never seen in benign hyperactivity. This woman was given radium and is alive, well, and without any symptoms suggestive of cervical carcinoma.

CASE 17. (Path. 44279). V. K., aged 61 years, the mother of 5 children, came to the hospital December 14, 1936, complaining of uterine descensus for 3 months. Examination showed a relaxed vaginal outlet and a second degree uterine descensus. She had

had an amputation of the cervix, an anterior and posterior colporrhaphy, and a dilatation and curettage. Before operation the cervix was found to be small, firm, and bilaterally lacerated. The portio was clean, smooth, and pink, except for very slight injection around the os. Careful gross examination of the cervix with a magnifying glass after operation disclosed no peculiar conditions of the portio epithelium, even though we knew from the section the position of the "carcinoma" around the os. The microscopic slide contained a section from each lip of the cervix. A non-invasive potential "carcinoma" was found at the external os on the anterior lip, and, in a thin layer, it extended out over the portio for nearly 1 centimeter. This woman was given radium, and a recent biopsy examination of the cervical stump showed no evidence of malignancy.

CASE 18. (Path. 45133). N. S., aged 56 years, who had had two children and three miscarriages, came to the hospital June 11, 1937, complaining of a "sore growth at the outlet of the bladder," dysuria, a persistent slight vaginal discharge, and "a feeling as though the womb was falling out" of the pelvis. Examination disclosed chronic inflammation and some prolapse of the urethral mucosa, a relaxed vaginal outlet with cystocele and rectocele, and slight descensus of the uterus. The cervix was small, roughened, and irregular, and transversely lacerated. The portio was generally injected and there was a zone around the os which was sunken, granular, irregular, red, and which bled easily on examination. Several biopsy examinations were taken from this perioral zone of erosion. The microscopic slide showed three small fragments of cervical tissue, near one of which there was a detached, thin strip of non-invasive potential "carcinoma" 2 millimeters long (Fig. 17). The hyperchromatic nuclei cause it to stand out sharply from the normal squamous epithelium of the neighboring fragments. There was only about one mitosis per high power field. This patient was given radium and thus far has shown no evidence of the persistence of the lesion.

An analysis of these 18 cases shows that all the women were or had been married; 41 per cent were under the age of 40, and their average age was 46 years when the carcinoma was first discovered. The two extremes in age were 27 and 62 years. The menstrual onsets included the ages of 12 through 16, the average age being 14 years. Seven of the patients were beyond normal menopause, the average time being 7 years. One had had a surgical menopause as the result of a bilateral salpingo-oophorectomy; 2 had had hysterectomies. Five had had some dysmenorrhea. In all cases the menstrual durations and intervals were within normal limits. All but one woman had been pregnant, and the series had had a total of 53 babies and 14 abortions, an average of 3.0 babies and 0.8 abortions per woman or 3.8 pregnancies. One woman had had 12 babies and 3 had had only 1. Four women had had prolapse of the uterus, 2 with procidentia and 2 with second degree; 3 of these had worn pessaries. Three had had gonorrhea; 1 had also had buboes. The mother of 1 woman had died of cancer. Nine, or 50 per cent, complained of leucorrhea. Seven had had metrorrhagia, and in 2 of these it had been post-coital. Three women were found to have retroposition of the uterus.

Seven came to the hospital because of slight metrorrhagia (9 cervices showed eversion or erosion and 7 bled upon examination), 4 came because of prolapse of the uterus, and 2 came because of lower abdominal pain and leucorrhea. One woman came for each of the following causes: infectious arthritis, dysuria, dyspareunia, menorrhagia apparently due to uterine myomas, and for verification of the diagnosis of cervical polyp made by her family physician.

Thirteen of the cervices, or 72 per cent, were transversely lacerated, and in 3 of these the lacerations were very deep and extended down to the vaginal wall. Thirteen cervices showed eversion, erosion, or some injection around the os, while 4 were hypertrophied. In 3 cases the "carcinoma" was found in a cervical stump. The original pathological diagnosis in 9 cases was "epidermoid carcinoma of cervix," while in 7 it was "chronic cervicitis"; both polyps were called benign. As far as we were able to determine, from making serial sections of all available tissue on these cases, all of the growth was apparently removed with the specimen in 4 of the 5 trachelorrhaphies, the 2 amputations, and the 1 panhysterectomy. In 9 of the 11 other patients subjected merely to biopsy, sectioning of the remaining available tissue did not allow us to make up our minds definitely on this point, although in one instance it might well have all been removed (Case 8). Five of the "carcinomas" were found in the V-shaped wedge of cervical tissue removed when the trachelorrhaphy was done.

In most of Schiller's cases the growth has been found centered at the external os at the

junction of the cylindrical and squamous epithelium, and he has stressed this fact. This is further borne out by the finding of 11 of our non-invasive potential "carcinomas" at the same junction, despite the fact that half of our lesions were found in biopsy fragments. Five of our "carcinomas" were found relatively localized to childbirth lacerations. We wish to draw attention to the fact that Smith and Pemberton's (17) 3 cases of early cervical "carcinoma" which later became invasive were found in tissue removed during trachelorrhaphy.

The microscopic pictures of these 18 cases were essentially similar in that the cells all showed typical anaplastic changes, all of the growths were non-invasive and had lost most of the stratification seen in normal squamous epithelium, and all stood out rather sharply from the adjacent benign epithelium.

Case 2, in which the "carcinoma" became invasive after 8 years, and Case 13, in which invasion began about 3 years after biopsy, present some evidence that these non-invasive "carcinomas," as Schiller believes, are potentially invasive. Smith and Pemberton's 3 cases are of similar significance. Since only 2 of our cases developed into clinical "cancers," one of which was later directly fatal, it might appear that the potential invasiveness of these lesions is questionable. However, as was stated above, in 7 of our cases all of the lesion was apparently removed. Of the 11 others 2 later developed into an invasive growth. Five of the cases in which biopsy was done were recognized as "carcinoma" and were given adequate radium treatment. Of the 4 cases remaining 2 patients were given thorough cervical cauterization following biopsy, and in 1 of these all of the growth might well have been removed by the extensive stripping of the squamous epithelium from the portio and the curettage of the canal of the stump. This leaves 2 non-invasive potential "carcinomas" apparently unaccounted for: Cases 5 and 11. We have not been able to follow Case 5, and in Case 11 the patient was alive and well when last heard from in July, 1936.

The trachelorrhaphy specimen removed from Case 2, June 30, 1919, showed non-invasive "carcinoma," and when she was seen on February 28, 1928, 8 years and 8 months later, she had an advanced carcinoma of the cervix. It had then been symptomatic for 4 months, and when Stahler's mathematically evolved 2.7 month asymptomatic postinvasive period (28) is added it gives a 6.7 month invasive growth period to this tumor. In subtracting this from the total time interval a known non-invasive existence of 8 years and 1.3 months is established. Case 13 showed early asymptomatic carcinoma in the posterior lip of the cervix at the time of death, 3 years after the first biopsy was taken. From the extent of the growth we might assume that invasion had taken place from 2 to 4 months before death, in which case we establish a known non-invasive period of 2 years and 9 months for the original superficial lesion. By similar calculations Smith and Pemberton's (17) Case 1 had an established 3 year and 1.3 month non-invasive period, with a 10.7 month invasive growth phase. If, on the basis of 6 months being the average duration of symptoms in large groups of cases (6), we assume 8.7 month invasive phases for his other 2 patients, Case 2 would have a non-invasive period of 4 years and 0.3 months, while Case 16 would have one of 5 years and 4.3 months. Thus, from the data on these 5 cases, we find that the established known non-invasive periods vary from 2 years and 9 months to 8 years and 1 month.

In our Case 11, in which the biopsy specimen taken in 1930 showed non-invasive potential "carcinoma," the patient has as yet received no treatment and was well and without suggestive symptoms in July, 1936, exactly 6 years later. The 2 biopsy examinations in our Case 13 (Figs. 10 and 11) show the same "level" of anaplasia and activity. When they are compared to a portion of the superficial growth (Fig. 13) on the same cervix 3 years later a striking resemblance is still apparent even though by this time invasion has begun from the surface lesion about 2 millimeters away.

THE DIAGNOSIS OF NON-INVASIVE POTENTIAL "CARCINOMA" OF THE CERVIX

A full knowledge and understanding of the various elements which constitute non-in-

vasive potential "carcinoma" of the cervix is essential for accurate diagnosis. In the first place the component cells exhibit those signs generally accepted as characteristic of malignant cells. The nuclei, instead of showing the uniformity seen in normal stratified squamous epithelium, present a total absence of uniformity; they may be as much as six times the size of their neighboring nuclei, and may be round, oval, flattened, or slightly curved or twisted. Some nuclei will take practically no stain at all and their chromatin will stand out prominently like a lattice-work over a window; their nucleoli usually stain a bit darker and are relatively larger than those in the nuclei of benign cells. Other nuclei may be hyperchromatic, taking a dense "black" visually impenetrable hematoxylin stain. There may be all degrees of staining density between these two extremes, and there may be some intranuclear variations as well. The important point is that the nuclear staining densities bear no relation whatever to the size of the nuclei. In normal cells the larger the nucleus the lighter the stain and vice versa; in the malignant ones there may be an extremely large "black" nucleus in a cell which lies adjacent to one containing a pale staining nucleus one-sixth its size. There may be occasional large cells with a dozen nuclei in them. The cytoplasmic cell borders generally are not easily discernible and the cells lie in such a close-packed heterogeneous confusion that one receives the impression that there are a relatively greater number of nuclei per high power field than in normal epithelium. The presence of large darkly stained round or oval nuclei in cells on the surface of the growth is characteristic of this superficial "carcinoma," and the compact spinal cell outer layer is nearly always absent. The stratification of the cells normally seen in squamous epithelium is frequently absent although some definite semblance of it may remain.

The border between the normal epithelium and the "carcinoma" is nearly always sharp, and while in some cases it may be perpendicular, it is usually and characteristically of a 45 degree obliquity, the superficial portion leaning toward the new-growth. The basal layer consists usually of more or less spindle shaped cells closely lined up in a single intact layer. Although there may be the same changes in the contour of the basal layer as are found in normal squamous epithelium, e.g., shallow tongues of cells dipping into the stroma, complete epidermization of a superficial gland, etc., the stroma must not be invaded. No specific changes in the elastic tissue of the stroma beneath these growths can be demonstrated (27).

These "carcinomatous" cells, as Best's stain will show, do not contain the glycogen found in the spinal and some superficial transitional cells in normal stratified squamous epithelium. There may be a characteristic lymphocytic infiltration in the stroma beneath and in that extending just beyond the border of the growth. The growth activity, as manifested by the relative number of mitoses per high power microscopic field, in our cases does not bear any definite relation to the relative degree of anaplasia of the cells. We wish especially to stress this fact. Many times we have observed as high as 6 mitoses per high power field in a perfectly benign tongue of epithelium in the process of growing into a superficial gland during the repair of an inflammatory cervical condition. In a rapidly advancing and enlarging cancer the cell multiplication rate must of necessity be very high, and a correspondingly large number of mitotic figures per high power field will naturally be found; here their presence is undoubtedly of some aid in making the microscopic diagnosis of malignancy. As a rule the presence or absence of mitotic figures in a non-invasive potential "carcinoma" of the cervix has been of little or no diagnostic value, and in the final analysis the diagnosis can be made only when the anaplastic nuclear changes and non-uniformity of cell arrangement described herein are present.

DEFINITION AND SIGNIFICANCE OF NON-INVASIVE POTENTIAL "CARCINOMA" OF THE CERVIX

Non-invasive potential "carcinoma" of the cervix is a lesion composed of anaplastic epithelial cells which apparently arises spontaneously in a "growth center" at the junc-

tion of the squamous and columnar epithelium of the portio of the cervix. It lies within the usual domain of the normal stratified squamous epithelium and has remained relatively localized in a few accurately observed cases for from 3 to 8 years, after which it may break through the basement membrane and invade and destroy the stroma of the cervix, having then become clinically a cancer.

The fact that some of these lesions apparently do not become invasive cancers suggests that possibly all are not potential "carcinomas." However, the possibility of the destruction of these superficial growths during their several years dormancy by the necroses and erosions of trauma and intercurrent infections looms rather formidably when carefully considered.

If all clinical cervical carcinomas are preceded by this non-invasive phase, then routine biopsy of all cervices even once a year might be a guarantee against the development of cervical cancer. Although we feel that in our Case 13 we have been able to demonstrate fairly well the growth continuity through the non-invasive to the invasive phase we cannot say definitely that the invasive carcinoma in our Case 2 developed from the non-invasive growth discovered 8 years previously. As W. G. MacCallum has stated: "It is natural that the development of the carcinoma should be connected with the original change but it does not seem quite proven" (8). However, if a patient without symptoms is found repeatedly to have a growth of Escherichia coli in cultures of the urine from one kidney and, after a period, has an acute flare-up of pyelitis in that kidney, the urine giving a heavy growth of the same organism, we naturally assume that the original bacillus was the cause of the acute inflammation.

Among the obvious questions raised by a consideration of these lesions are the following: Is every cervical cancer preceded by a non-invasive phase of one or more years? Will every non-invasive potential "carcinoma" of the cervix eventually invade the stroma if the woman lives long enough and the growth is not destroyed? What are the factors determining the breaking through of the stromal defenses by the anaplastic epithelial cells? If some of these growths are not potentially invasive could they be differentiated from those that are? These and other queries on the subject will be answered only when many more of these cases are assembled and carefully studied.

SUMMARY

1. Cancer is the second most frequent cause of death in the western world; cancer of the uterus is responsible for one-third of the cancer deaths in women; 90 per cent of uterine cancer arises in the portio of the cervix and is thus easily accessible for examination and study.

2. The most favorable statistics from the treatment of cancer when it is limited to the portio of the cervix show a 52 per cent cure, while not more than 20 per cent of all cervical cancers have a 5 year cure.

3. Schottlaender and Kermauner (1912) and Schiller (1927) have described and called attention to a form of superficial non-invasive cervical "carcinoma." Schiller considers and treats it as definite carcinoma.

4. The authors present 18 cases for which one of them (C. S. S.) has proposed the name "non-invasive potential 'carcinoma' of the cervix."

5. In 1 patient (Case 2) the "carcinoma" remained non-invasive for 8 years and 1 month, following which it developed into a clinical carcinoma and finally caused the death of the patient. A second patient (Case 13) died of pernicious anemia 3 years after the first biopsy examination revealed a non-invasive potential "carcinoma." Serial sections of this cervix revealed that invasion had taken place shortly before death.

6. Non-invasive potential "carcinoma" of the cervix is defined and its diagnosis is discussed as well.

7. The authors hope that similar studies of the material in other pathological laboratories will be carried out, for when many of these cases are thus unearthed and studied we will be able to draw more valuable conclusions and to throw light on the as yet unanswerable questions on this subject.

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ACUTE PUTRID ABSCESS OF THE LUNG

II. An Analysis of Forty-Five Consecutive Operative Cases

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IN a recent publication[1] we presented evidence in favor of operation in the *acute* stage of putrid abscess of the lung, based upon a study of the pathological and clinical features of the disease as observed in a large series of cases in all stages. Operative indications were discussed, our operative methods were described in detail, and the results obtained in the surgical treatment of 37 consecutive acute cases were outlined. We defined an "acute" abscess arbitrarily, on the basis of time alone, as one of not more than 6 weeks' duration from the time of onset of pulmonary manifestations. Some of the points which were emphasized and which have a bearing on the present communication, are as follows: (1) An understanding of the pathology of acute abscess of the lung constitutes the foundation of correct treatment, and in particular of correct operative treatment. (2) Certain pathological features such as the superficial location of the abscess within the lobe and the presence of overlying pleural adhesions, indicate the feasibility of operation in the acute stage. (3) The inflammatory process is well localized in the early phase. (4) In the later phases it becomes widespread, and secondary changes occur in the surrounding pulmonary parenchyma and bronchial tree. These changes are responsible for the lower incidence of cure and the higher incidence of morbidity and mortality in the subacute and chronic cases. (5) Acute cases may be classified as "mild" or "grave." Spontaneous subsidence may occur, less often in the latter than in the former. In those cases in which the process does not subside fatal complications develop early in the course of the disease or they pass into the chronic phase. (6) The seriousness of putrid abscess of the lung can be appreciated only if the manifestations of the chronic phase, and the complications with their mortality, are borne in mind. (7) Although clinical manifestations usually settle the question of operative intervention in individual cases, it can be stated, in general, that the great majority of patients with "grave" lesions should be subjected to operation in the acute stage. (8) The operative method which we advocate consists essentially of a single-stage procedure in which the lesion is entered through overlying pleural adhesions, unroofed, and packed. (9) Exact diagnostic localization of the lesion is a prerequisite for the operative methods which we employ. In the absence of precise pre-operative localization of the abscess, the operation as described is not recommended.

The present paper is based upon a study of 45 consecutive operative cases of acute putrid abscess of the lung,[2] treated in accordance with principles stated in our previous communication. These patients represent the total number treated by operation in a series of more than one hundred cases of acute putrid pulmonary abscess admitted to the Mount Sinai Hospital. Thus, every acute case that has come under observation has not been operated upon. On the other hand, it is to be emphasized that in no instance was operation withheld from a gravely ill patient for fear of increasing the operative mortality rate.

We began to operate upon patients with acute pulmonary abscess in 1925. In the beginning, operation was performed rarely and was reserved for patients who were desperately ill. In recent years, however, as our surgical indications have broadened, operation

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[1]Neuhof, H., and Touroff, A. S. W. Acute putrid abscess of the lung; principles of operative treatment. Surg., Gynec. & Obst., 1936, 63: 353–368.

[2]Since this paper was prepared for publication, 18 additional patients have been operated upon with satisfactory results in 17, and death in 1, several months after operation, from pulmonary complications not referable to the operated upon (and healed) acute pulmonary abscess.

has been carried out with increasing frequency.

Forty-two of the 45 cases herein reported, were operated upon by us; 3 by other members of this surgical service. Thus, by close collaboration and frequent exchange of opinion, we developed the present operative technique and general mode of management of cases of acute pulmonary abscess. Of vital importance has been the co-operation of the physicians of our institution, who, noting the results which have been obtained in these cases, now request early surgical consultation.

In this communication our 45 cases shall be analyzed for the purpose of presenting, partly in detail and partly in outline, their varying etiology, their clinical and roentgenographic features, the operative problems and findings, the operative sequelæ, and the results of operative treatment.

Classification. Incidence. For purposes of analysis and classification, the cases have been divided into two groups, unperforated and perforated. Thirty-four cases (Group A) were unperforated in the sense that the abscess was confined to the pulmonary parenchyma. In 11 cases (Group B), the complication of perforation into the pleura with pyopneumothorax existed prior to operation.

In our series the higher incidence of pulmonary abscess in males is to be noted (29 males, 16 females). An explanation will be offered in a succeeding paragraph. The youngest patient was 2 years of age, the oldest was 70. Thirty of the 45 cases occurred during the fourth, fifth, and sixth decades of life, the lowest incidence being noted at the extremes of life.

Location of lesions. In the 45 cases, the right lung was involved in 32, the left in 12, and both right and left in 1. A single abscess was present in 40 of the 45 cases. In 15 of these, it was located in one of the upper lobes; and in 20, in one of the lower lobes. In 5 cases it involved contiguous portions of two adjacent lobes by direct extension across an interlobar fissure. There were 5 cases in which more than 1 abscess existed. Of these, 3 had 2 abscesses lying immediately adjacent to each other, the lesions being situated in the upper lobe in all 3 instances. (We regard these as cases of solitary abscess in which more or less irregular extension into the adjacent pulmonary parenchyma had occurred.) In the fourth case (Case 37) there were 3 widely separated abscesses in the right lung. The last case (Case 45) presented several bilateral abscesses.

The point is that the great majority of patients had *single* lesions, a fact which supports the "*aspiration*" rather than the "embolic" theory of origin of putrid abscess of the lung. If the *embolic* mechanism were common, the pulmonary lesions frequently would be *multiple, widespread,* and *bilateral.* It is interesting, in this connection, to note that in the 1 case in this series (Case 45), in which an embolic mechanism properly could be invoked, the pulmonary lesions *were* multiple, widespread, and bilateral. A second fact, which suggests strongly that aspiration is responsible for the production of putrid abscess of the lung, is the much higher incidence of right sided as compared with left sided lesions in this series. The direct pathway from the trachea into the right main bronchus in contrast with the less direct one into the left main bronchus, would account for the preponderance of right sided lesions on the basis of aspiration.

Etiology. The etiology was definite in only 19 cases, as follows: tonsillectomy in 8 (2 under local anesthesia); extraction of teeth in 2 (both under local anesthesia); operations under general anesthesia in 2; incision of a peritonsillar abscess in 1; epileptic seizure in 1; acute tonsillitis in 1; spillover from a chronic pulmonary abscess in 1; sepsis after therapeutic abortion in 1; and laceration of the esophagus in 2. In these last 2 cases the pulmonary abscess was the result of direct extension of infection from the mediastinum into the adjacent lung.

In the 26 remaining cases the etiology was "uncertain." In a recent article, Stern[1] of this institution reported his investigation concerning the cause of putrid abscess of the lung in a series of cases of obscure etiology. In 84 per cent of cases in which the etiology was not obvious, he found gross gingivodental infection, and unusually large deposits of dental

[1]Stern, L. Etiological factors in the pathogenesis of putrid abscess of the lung. J. Thoracic Surg., 1936, 6: 2, 202.

GROUP A—ACUTE PUTRID ABSCESS OF LUNG

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
1 H.D. 1925 25–20 Male 24	Post-tonsillectomy (general anesthesia) 4 wks.	Typical except for profuse non-foul sputum 12-20 oz. q.d.	2-inch cavity R.U.L. surrounded by dense infiltration	R.U.L. bronchus occluded by extra bronchial pressure. No secretion present	Axillary segment R.U.L. 1 wk.	*One stage.* Local anesthesia. Anterior axillary approach through 3rd rib. Pleural adhesions. Abscess unroofed	Satisfactory, except for slight bleeding at first dressings. Discharged 3½ wks. after operation	Uneventful. Bronchial fistula maintained for 2 mos.	Well. 9-year follow-up. Sympotm-free. Normal x-ray
2 I.E. 1928 313,793 Male 54	Unknown 3 wks.	Septic course. High, irregular fever. Rapid enlargement of lesion	2-inch cavity R.U.L. anteriorly	Foul pus, anterior branch R.U.L.	Anterior segment of R.U.L. 2 wks.	*One stage.* Local anesthesia. Anterior approach, through 2nd rib. Pleural adhesions. Abscess unroofed	Uneventful. Discharged 6 wks. after operation	Uneventful. Bronchial fistula maintained for 2 years because of large cavity	Well. 7-year follow-up. Sympotm-free. X-ray: clean defect at site of previous abscess. Has active Graves' disease
3 A.R. 1929 319,084 Male 57	Indeterminate (poor dental and oral hygiene) 2 wks.	Downhill course, high fever, loss of weight, profuse expectoration	Area of infiltration 2 in. x 3 in., containing a fluid level in R.L.L. laterally	Not performed	R.U.L. and adjacent R.L.L. 3 wks.	*One stage.* Local anesthesia. Anterior axillary approach through 4th rib. Pleural adhesions. Multilocular abscess unroofed Second operation 2 mos. after first operation. One stage. G-O anesthesia. Paravertebral approach through 6th and 7th ribs. Pleural adhesions. 4-in. abscess unroofed	Unsatisfactory. Persistent symptoms. Recurrent hemoptysis. Persistent pulmonary infiltration in R.L.L. Uneventful. Discharged 2 mos. after operation	Uneventful. Posterior bronchial fistula maintained for 1 year because of large cavity	Well. 7-year follow up. Sympotm-free. Pinpoint anterior fistula still present which patient refuses to have closed. X-ray normal except residual fibrosis at site of former lesion
4 B.C. 1930 358,926 Male 45	Indeterminate (poor dental and oral hygiene) 2 wks.	Marked prostration, apathy and toxemia. Diabetes mellitus	Cavity R.U.L. anteriorly—apex to 3rd rib. Little surrounding infiltration	Not performed	Anterior segment of R.U.L. 5 days	*One stage.* Local anesthesia. Anterior approach through 3rd rib. Pleural adhesions. 4-in. cavity unroofed	Uneventful. Discharged 3 wks. after operation	Uneventful. Bronchial fistula maintained for 9 wks.	Well. 3-year follow-up. Sympotm free. Normal x-ray. Then death from cancer of stomach. Lungs negative at postmortem examination
5 A.S. 1930 319,536 Female 20	Post-tonsillectomy 10 days	Septic course. High fever and very rapid pulse. Extensive infiltration	Pneumonic infiltration 3rd to 7th rib posteriorly R.L.L. 1¼-in. cavity at level of 5th rib	Foul pus, lateral and posterior branches R.L.L.	Apical segment of R.L.L. 11 days	*Two stages. 1st stage.* Local anesthesia. Paravertebral approach through 5th and 6th ribs and transverse processes. Pleura inadvertently opened. Adhesions at 5th but not at 6th rib. Lung sutured to parietes. Wound packed. *2nd stage,* 4 days later. No anesthesia. 2½-in. cavity in mediastinal aspect of lower lobe unroofed	Uneventful. Discharged 6 wks. after operation	Bronchial fistula maintained for 2 mos. Cough and slight nonfoul sputum for 1 year after operation	Well. 4¼-year follow-up. Sympotm-free. X-ray: clean defect at site of previous abscess

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
6 T.S. 1931 322,870 Male 37	Unknown 3 wks.	Septic course, high fever, very rapid pulse, profuse expectoration. Rapid enlargement of lesion	Extensive infiltration. Large cavity in upper part of R.L.L. posteriorly	Foul pus, apical branch R.L.L.	Apical segment of R.L.L. 10 days	*One stage.* Local anesthesia. Paravertebral approach through 7th rib and transverse process. Pleural adhesions. Very large cavity unroofed	Uneventful. Discharged 3 wks. after operation	Uneventful. Bronchial fistula maintained for 5 weeks	Well. 4-year follow-up. Symptom-free. Normal x-ray
7 M.C. 1931 326,427 Female 16	Post-tonsillectomy (general anesthesia) 11 days	High fever, septic course, rapid increase of pulmonary excavation. Profuse expectoration	Diffuse pneumonic infiltration mesial portion of base of R.L.L. with cavity formation	Small amount of foul pus, posterior branch R.L.L.	Mesial segment R.L.L. (mediastinophrenic aspect) 8 days	*Two stages. 1st stage.* Local anesthesia. Posterolateral approach through 9th rib. No parietal pleural adhesions present. Pleura opened and explored. Adhesions found between under surface of lower lobe and diaphragm. Lesion shut off from free pleura by suture and packing *2nd stage,* 3 days later. No anesthesia. Through previously prepared operative field, 1½-in. cavity unroofed	Uneventful except for irregular fever for 2 wks. Discharged 33 days after operation	Uneventful. Bronchial fistula maintained for 2 mos.	Well. 3½-year follow-up. Symptom-free. Normal x-ray
8 J.M. 1931 328,417 Male 59	Indeterminate (poor dental and oral hygiene) 18 days	High fever, night sweats. Rapid loss of weight	Encapsulated pleural effusion in lateral half of chest apex to base	Not performed	Posterolateral segment R.L.L. 5 days	*One stage.* Local anesthesia. Posterolateral approach, through 7th rib. Pleural adhesions present. Large cavity unroofed. This lesion was small compared with the empyema seen by x-ray. Pleura aspirated in 6th interspace. Foul pus obtained. 6th rib resected and large putrid empyema evacuated. No communication between abscess of lung and empyema. *Not a case of perforated lung abscess*	Uneventful. Discharged 24 days after operation	Uneventful. Bronchial fistula maintained for 2 wks.	Well. 3 months' follow-up. Failed to return thereafter. When last seen was symptom-free. Wound healing. X-ray negative except for slight residual pleural thickening

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, year, admission No. / Sex age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
9 J.U. 1931 331,021 Male 42	Indeterminate (poor dental and oral hygiene) 3 wks.	Typical. Later presented features of a "shut-off" lesion with continuing fever	Infiltration and cavity in lower part of rt. chest anteriorly	Small amount of foul pus, posterior branch R.L.L.	R.M.L. and adjacent segment of R.L.L. 6 days	*Two stages. 1st stage.* G-O-E anesthesia. Anterolateral approach through 5th rib. No parietal pleural adhesions. Pleura opened and explored. Adhesions present between R.M.L. and R.L.L. and between R.L.L. and diaphragm. Lung sutured to parietes *2nd stage*, 6 days later. No anesthesia. Through previously prepared operative field, 1½-in. cavity unroofed. Drainage of infected pneumothorax. No pus present. Fibrinous exudate on walls of pneumothorax cavity	Intractable hiccough. Fever. Phrenicectomy for control of hiccough Septic fever. Toxic psychosis, cerebral embolism? Infected pneumothorax Convulsions, probably due to cerebral embolism	Died 4 days after thoracotomy in convulsions	Died. Postmortem No. 7997. Drained putrid lung abscess R.L.L. and R.M.L. Gangrenous pleuritis. *No brain examination*
10 J.P. 1932 344,449 Male 50	Indeterminate (poor dental and oral hygiene) 4 wks.	Fulminating course. Marked prostration and apathy. Rapid enlargement of cavity. Rapid loss of weight. Chills	Pneumonic infiltration upper part of lt. chest, 1st to 3rd rib anteriorly. 2-in. cavity within area of infiltration	Small amount of foul pus, anterior descending branch L.U.L.	Apical segment L.U.L. 11 days	Local anesthesia. Anterior approach through 2nd rib. No pleural adhesions. *Surgical approach obviously incorrect.* Wound closed. Reoperation 1 wk. later. *One stage.* Local anesthesia. Paravertebral approach, through 7th rib. Pleural adhesions. Bilocular cavity. One locule 4 in. in diameter, 2nd locule 3 in. in diameter. Both unroofed	Further diagnostic studies. Re x-ray (lateral) revealed lesion to lie posteriorly Satisfactory for 3 days. Then chills with spiking temperature due to thrombophlebitis of large vessel exposed in cavity. After 3 days spontaneous subsidence. Discharged 7¼ wks. after operation	Uneventful. Bronchial fistula maintained for 7 mos. because of large size of cavity	Well. 3½ year follow-up. Symptom-free. Normal x-ray and bronchogram
11 C.S. 1932 345,939 Male 39	Indeterminate (poor dental and oral hygiene) 4 wks.	Three frank hemoptyses before admission to hospital	Pulmonary infiltration rt. lung 1st–5th rib posteriorly. At 3rd interspace 2-in. cavity with fluid level	Thick pus, paravertebral branch R.U.L.	Posterior segment R.U.L. 11 days	*One stage.* Avertin G-O anesthesia. Posterolateral approach through 3rd rib. Pleural adhesions. Bilocular cavity with unusually stiff walls, unroofed	Uneventful. Discharged 2½ wks. after operation	Uneventful. Bronchial fistula maintained for 3½ mos.	Well. 3-year follow-up. Symptom-free. Normal x-ray and bronchogram
12 A.W. 1932 369,801 Male 27	Post-epileptic seizure 10 days	Irregular septic temperature (101°–104°)	Pneumonic infiltration involving most of R.U.L. 1½-in. cavity in mesial part of lobe, just beneath clavicle	Pus, paravertebral branch R.U.L. and apical branch R.L.L.	Upper part of rt. lower lobe and adjacent R.U.L. 7 days	*One stage.* Local anesthesia. Paravertebral approach, through 6th rib. Pleural adhesions. Bilocular cavity partially in R.L.L. and partially in R.U.L. unroofed. Lobes agglutinated	Numerous epileptic seizures. Postoperative toxic psychosis. Discharged 9 wks. after operation	Uneventful. Bronchial fistula maintained for 3 wks.	Well. 3½-year follow-up. Symptom-free except for some pain in rt. axilla (intercostal nerve origin ?). Normal x-ray and bronchogram

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
13 I.R. 1933 352,100 Male 36	Indeterminate (poor dental and oral hygiene) 4 wks.	Profuse hemoptysis at onset	Dense shadow axillary portion lt. chest. No cavity visible	Foul pus, anterior and axillary branches L.U.L.	Axillary segment L.U.L. 7 days	*One stage.* Avertin G-O anesthesia. Posterior axillary approach through 4th rib. No pleural adhesions found. Pleura opened and explored. Adhesions found at lower level. Pleura closed. 5th rib resected. Pleural adhesions. 4-in. cavity in lung unroofed. Several accessory loculations present	Uneventful. Discharged 12 days after operation	Uneventful. Bronchial fistula maintained for 2 mos.	Well. 3-year follow-up. Symptom-free. Normal x-ray
14 M.W. 1934 368,587 Male 60	Indeterminate (poor oral and dental hygiene) 4 wks.	Fulminating course. High fever. Marked toxemia. Rapid enlargement of cavity	Dense pneumonic infiltration—lateral portion of L.U.L. Several fluid levels	Not performed	Axillary segment L.U.L. 1 day	*One stage.* Local anesthesia. Axillary approach through 5th rib. Free pleura inadvertently entered adjacent to pleural adhesions. Lung sutured to thoracic parietes. Large abscess unroofed. 3 days after first operation, re-operation	Postoperative fever. Profuse non-foul expectoration. X-ray revealed undrained abscess lying posterior to the drained cavity.		
						One stage. No anesthesia. Through existing wound, large cavity unroofed	Uneventful. Discharged 3½ wks. after operation	Satisfactory except for occasional bloody expectoration during early course	Suicide 4 mos. after operation. Bronchial fistula was being maintained. Normal x-ray and symptom-free at time of death
15 A.S. 1934 365,580 Female 2	Post-tonsillectomy (general anesthesia) 10 days	Septic fever 101°–105°. Marked apathy	Infiltration entire R.L.L. containing several cavities with fluid levels. Largest cavity 2 in. diameter	Foul pus, R.M.L. and apical branch R.L.L.	Anterior segment of R.L.L. and adjacent R.M.L. 5 days	*One stage.* Ether anesthesia. Posterolateral approach through 7th rib. Pleural adhesions. 1½-in. cavity, unroofed. Free pleura adjacent to adhesions inadvertently entered. Opening protected with packings. Several adjacent pulmonary loculations unroofed	Uneventful. Large clean pulmonary defect closed by plastic operation 3 wks. after original operation. Discharged 3 wks. after 2nd operation, with wound healed	Uneventful	Well. 2-year follow-up. Symptom-free. Normal x-ray
16 H.R. 1934 376,983 Female 40	Indeterminate (poor dental hygiene) 3 wks.	High septic fever. Chilliness, prostration, profuse night sweats. Progressive course suggesting perforation	Large cavity L.U.L. apex to 2nd interspace anteriorly. Considerable surrounding pulmonary infiltration	Foul pus, apical and paravertebral branches L.U.L.	Apical segment L.U.L. 7 days	*One stage.* Avertin G-O anesthesia. Posterior paravertebral approach through 6th rib. Pleural adhesions. 4-in. cavity unroofed	Postoperative bronchopneumonia (non-putrid) of L.L.L. Discharged 6 wks. after operation	Uneventful. Bronchial fistula maintained for 3½ mos.	Well. 2-year follow-up. Symptom-free. Normal x-ray and bronchogram

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
17 J.M. 1934 371,988 Male 42	Indeterminate (poor dental and oral hygiene) 2 wks.	Fulminating course. Frank hemoptysis. Rapid enlargement of cavity	Large area pneumonic infiltration, extreme lt. base, containing 2-in. cavity	Not performed	Posterolateral segment of L.L.L. 2 days	*One stage.* Avertin anesthesia. Posterolateral approach through 10th rib. Pleural adhesions. 2-in. cavity in lowermost portion of L.L.L. unroofed	Uneventful. Discharged 3 wks. after operation	Uneventful. Bronchial fistula maintained for 3 wks.	Well. 2-year follow-up. Symptom-free. X-ray and bronchogram normal
18 J.L 1935 376,096 Male 61	Unknown 2 wks.	Typical	Large cavity with fluid level L.L.L. 6th to 10th ribs posteriorly	Not performed	Posterior segment of L.L.L. 3 days	*One stage.* Avertin G-O anesthesia. Posterior paravertebral approach through 7th rib. Pleural adhesions. 4-in. multilocular cavity unroofed	Uneventful. Discharged 23 days after operation	Satisfactory	Died following operation for strangulated femoral hernia 3 mos. later. Bronchial fistula was being maintained. Patient was free of pulmonary symptoms
19 M.T. 1935 379,281 Male 53	Indeterminate (poor dental and oral hygiene) 5 wks.	Typical. Diabetes mellitus	2½-in. abscess cavity with fluid level apical portion R.L.L. 6th to 8th ribs posteriorly close to vertebral column	Foul pus, apical branch of R.L.L.	Apical segment of R.L.L. 5 days	*One stage.* Avertin G-O anesthesia. Posterior paravertebral approach through 7th rib. Pleural adhesions. 2-in. multilocular cavity unroofed	Uneventful. Discharged 5 wks. after operation	Uneventful. Bronchial fistula maintained for 2 mos.	Well. 2-year follow-up. Symptom-free. X-ray and bronchogram normal
20 B.H. 1935 381,199 Male 66	Post tooth extraction (local anesthesia) 3⅕ wks.	Typical. Diabetes mellitus	Pneumonic infiltration axillary and parasternal portions of R.U.L. Several areas of cavitation within infiltrated area	Not performed	Anterior segment of R.U.L. 5 days	*One stage.* Avertin G-O anesthesia. Anterolateral approach through 3rd rib. No pleural adhesions noted. Pleura inadvertently opened and explored. Adhesions found more mesially. Lung sutured to thoracic parietes. Large multilocular cavity unroofed	Uneventful for 2 wks. then recurrence of fever and foul sputum. X-ray revealed cavitation mesial to the drained abscess		
						2nd operation—*one stage.* Avertin G-O anesthesia. Existing wound enlarged, 3rd rib resected more mesially. Pleural adhesions present. Large cavity unroofed	Uneventful except for toxic psychosis. Discharged 2⅕ wks. after operation	Uneventful. Bronchial fistula maintained for 7 wks.	Well. 2-year follow-up. Symptom-free. X-ray normal

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
21 S.F. 1935 386,358 Female 32	Post-tonsillectomy (local anesthesia) 2 wks.	Typical	Pneumonic infiltration mesial portion of base of R.L.L.	Foul pus, mesial branch of R.L.L.	Mesial segment of R.L.L. (mediastinophrenic aspect) 9 days	*One stage.* Avertin G-O anesthesia. Posterolateral approach through 10th rib. No parietal pleural adhesions present. Pleura opened and explored. Pleural adhesions present between under surface of lower lobe and diaphragm. Lesion shut off from free pleura by suture and packing. Cavity unroofed	High fever, toxic psychosis. Sterile hydropneumothorax. Discharged 10½ wks. after operation	Uneventful. Bronchial fistula maintained for 1 wk. after leaving hospital	Well. 1½-year follow-up. Symptom-free. X-ray normal
22 G.F. 1935 385,080 Male 37	Indeterminate (poor dental and oral hygiene) 1 wk.	Unusually profuse sputum 20–30 oz. q.d. Sputum odorless	Dense shadow lower part of R.U.L. In mesial part is a 2-in. cavity with fluid level	Small amount of foul pus, paravertebral branch of R.U.L. and apical branch of R.L.L.	Lower segment of R.U.L. and adjacent R.L.L. 8 days	*One stage.* Avertin G-O anesthesia. Posterior paravertebral approach through 6th rib. Pleural adhesions. Large bilocular cavity partially in R.U.L. and partially in R.L.L. unroofed	Uneventful. Large clean defect in lung closed by plastic operation 7 wks. after original operation. Discharged 17 days after 2nd operation with wound healed	Uneventful	Well. 1¼ year follow-up. X-ray and bronchogram normal. Bronchoscopy negative
23 M.McL. 1935 389,583 Female 32	Post-tonsillectomy (general anesthesia) 2 wks.	Fulminating course, chills, high fever, rapid loss of weight	Cavity with fluid level at apex of R.U.L. posteriorly	Not performed	Apical segment of R.U.L. 4 days	*One stage.* Avertin G-O anesthesia. Posterior paravertebral approach through 4th rib. Pleural adhesions. 3-in. cavity unroofed	Uneventful except for slight bleeding at first dressings. Discharged 4 wks. after operation	Uneventful. Bronchial fistula maintained for 10 wks.	Well. 1½-year follow-up. Symptom free. X-ray normal
24 S.S. 1935 391,776 Male 48	Unknown 9 days	Fulminating course, high fever, profuse sputum, dyspnea and rapid enlargement of cavity	Infiltration axillary portion of L.U.L. just above interlobar fissure. Two irregular cavities present	Granulation tissue in L.U.L. bronchus. No secretion ("shut-off" lesion) ¾	Axillary segment of L.U.L. 1 day	*One stage.* Avertin G-O anesthesia. Axillary approach through 5th rib. Pleural adhesions not present. Pleura opened and explored. Pleural adhesions present at a higher level. Lung sutured to parietes. 4th rib resected. Dense pleural adhesions present at this site. Large multilocular cavity unroofed	Uneventful. Discharged 4 wks. after operation	Uneventful. Bronchial fistula maintained for 4 mos.	Well. 1½-year follow-up. Symptom-free. Normal x-ray
25 E.A. 1935 388,063 Male 40	Post tooth extraction (local anesthesia) 3½ wks.	Very profuse expectoration. Rapid enlargement of cavity. Marked toxemia	Extensive area of consolidation upper part of R.L.L. containing a 2-in. cavity with fluid level	Not performed	Posterolateral segment of R.L.L. Operated upon on admission	*One stage.* Avertin G-O anesthesia. Posterolateral approach through 8th rib. Pleural adhesions. 3-in. cavity unroofed	Uneventful. Discharged 13 days after operation	Uneventful. Bronchial fistula maintained for 5 wks.	Well. 1½-year follow-up. Symptom-free. Normal x-ray
26 T.McK. 1936 388,797 Male 30	Indeterminate (poor dental and oral hygiene) 16 days	Typical	1-in. cavity with fluid level axillary region lt. lung. Moderate surrounding infiltration	Not performed	Posterolateral segment L.L.L. 4 days	*One stage.* Avertin G-O anesthesia. Posterolateral approach through 6th rib. Pleural adhesions. Cavity unroofed	Uneventful. Discharged 16 days after operation	Uneventful. Bronchial fistula maintained for 2 mos.	Well. 1½-year follow-up. Symptom-free. Normal x-ray

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Continued

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
27 S.M. 1936 392,108 Male 38	Unknown 5½ wks.	Typical	2-in. cavity with fluid level—anterolateral portion L.U.L. at level of 1st rib. Dense infiltration containing a suspicious area of cavitation in axillary portion of lobe	Foul pus, axillary branch of L.U.L.	Axillary and apical segments of L.U.L. 4 days	*One stage.* Avertin G-O-E anesthesia. Anterolateral approach through 3rd rib. Pleural adhesions. 1½-in. cavity unroofed. Narrow tract found extending upward into a second cavity 1½ in. in diameter in apex, unroofed	Uneventful. Clean defect in lung closed by plastic operation 24 days after operation. Discharged 3½ wks. after 2nd operation	Symptom-free except for occasional blood-tinged sputum at intervals for 1st 3 mos.	Well. 1-year follow-up. Symptom-free. Normal x-ray
28 A.J. 1936 396,037 Male 31	Post incision of peritonsillar abscess (no anesthesia) 6 days	Septic course. Spiking temperature 101°–106°, severe shaking chills, toxemia and toxic psychosis, apparently due to septic thrombophlebitis of pulmonary vein	3-in. x 3-in. area of infiltration R.L.L., 6th to 8th ribs posteriorly. Several small areas of rarefaction within infiltrated area. No definite fluid level	Not performed	Posterolateral segment R.L.L. 1 day	*One stage.* Local anesthesia. Posterolateral approach through 7th rib. Pleural adhesions. Large multilocular cavity containing large amount of necrotic lung unroofed	Septic manifestations with spiking temperature and chills continued for 4 days until death, but cough and foul sputum disappeared on 2nd day after operation		Died. No postmortem examination. Death apparently due to sepsis derived from septic thrombophlebitis of pulmonary vein, present before admission to hospital. Symptoms of lung abscess were subsiding at time of death
29 R.L. 1936 399,794 Male 60	Indeterminate (poor dental and oral hygiene) 3 wks.	Profuse expectoration. Frank hemoptyses. Profound prostration	4-in. area of consolidation paravertebral region R.U.L. 4th to 6th ribs. No cavity visible	Not performed	Paravertebral segment of R.U.L. Operated upon on admission	*One stage.* Local anesthesia. Paravertebral approach through 5th rib and adjacent transverse process. Pleural adhesions. 3-in. cavity unroofed. Recent extension into adjacent lung present	Uneventful. Discharged on 18th day after operation	Uneventful. Bronchial fistula maintained for 2 wks.	Well. 1-year follow-up. Symptom-free. Normal x-ray
30 S.E. 1936 400,544 Male 49	Unknown 3½ wks.	Typical	Localized area of consolidation, paravertebral segment R.U.L., containing small fluid level at level of 4th rib	Not performed	Paravertebral segment of R.U.L. 1 day	*One stage.* Avertin G-O anesthesia. Paravertebral approach through 5th rib. Pleura inadvertently entered and adhesions noted above. Pleura closed. 4th rib resected. Adherent pleura. 2-in. cavity unroofed	Improvement in general condition but foul sputum persisted and area of infiltration increased. Bronchoscopy revealed small amount of foul pus paravertebral branch of R.U.L.		
						2nd operation 10 days after first operation. *One stage.* Avertin G-O anesthesia. Approach through existing wound. Resection of 3rd rib. Adherent pleura. Abscess on mediastinal aspect of R.U.L. immediately above the drained cavity, unroofed	Uneventful. Plastic closure of large, clean cavity 3 wks. after 2nd operation. Discharged 3 wks. later with wound healed	Uneventful	Well. 1 year follow-up. Symptom-free

GROUP A—ACUTE PUTRID ABSCESS OF LUNG—Concluded

Name, year, admission No. / Sex age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
31 T.L. 1936 399,013 Female 31	Spillover from chron putrid abscess L.U.L. 10 days	Frequent hemoptyses	Cavity with fluid level axillary portion of L.L.L.	Foul pus, posterolateral branch L.L.L.	Posterolateral segment of L.L.L. 3½ wks.	*One stage.* Avertin G-O anesthesia. Posterolateral approach through old incision. Pleural adhesions. 1½-in. cavity in lower lobe unroofed	Subsequent drainage of chronic putrid empyema derived from original putrid abscess of lung. Discharged 7½ wks. after operation	Uneventful. Bronchial fistula maintained for 10 wks.	Well. 1 year follow-up. Symptom-free
32 N.S. 1936 402,959 Male 34	Postappendectomy (general anesthesia) 1 mo.	Frank hemoptysis	Area of infiltration near vertebral column 7th to 9th ribs posteriorly on rt. side. No fluid level	Not performed	Apical segment R.L.L. 5 days	*One stage.* Avertin G-O anesthesia. Paravertebral approach through 7th and 8th ribs. Filmy pleural adhesions. Pleura entered and explored. Dense adhesions present more mesially. Lung approximated to parietes. 2-in. cavity unroofed	Uneventful. Discharged 4 wks. after operation	Uneventful. Bronchial fistula maintained for 5 wks.	Well. 1 year follow-up. Symptom-free
33 I.G. 1931 372,532 Female 52	Laceration of esophagus by chicken bone 5 wks.	Persistent pain in chest, weakness, fever, foul sputum, and loss of weight	Dense infiltration, mesial half of R.U.L. 1½-in. cavity at level of 2nd and 3rd ribs posteriorly. Pneumothorax with 33 per cent collapse of rt. lung	Foul pus, apical branch of R.U.L.	Abscess of posterior mediastinum with extension into R.U.L. of lung 1 wk.	*Two stages. 1st stage.* G-O anesthesia. Paravertebral approach through 1st, 2nd, and 3rd ribs. Inadequate pleural adhesions. Pleura opened and packed locally *Second stage*, 9 days later. G-O anesthesia. Mediastinal abscess entered and evacuated. Abscess of lung then exposed and unroofed. Both lesions packed	Postoperative toxic psychosis	Uneventful. Bronchial fistula maintained for about 4 wks.	Five-year follow-up. Except for pain in operative scar, patient is symptom-free. X-ray negative
34 B.L. 1932 351,334 Female 40	Laceration of esohpagus by meat bone 11 days	Septic course, toxic psychosis, dyspnea and rapid pulse. Copious foul sputum	Infiltration mesial portion of R.U.L. apex to 2nd rib anteriorly. Within infiltrated area a fluid level extending from chest wall to a point beyond the midline	Foul pus, apical branch of R.U.L.	Large abscess of anterior, middle, and posterior mediastinum with extension into R.U.L. of lung Operated upon admission	*One stage.* G-O anesthesia. Paravertebral approach through 5th and 6th ribs. Large mediastinal abscess entered and evacuated. Abscess of lung exposed. Both lesions packed	Uneventful. Patient discharged 12 weeks after operation	Uneventful. Bronchial fistula maintained for 4 mos.	Well. 2½-yr. follow-up. Symptom-free. X-ray negative

tartar. The conclusion reached by him was that abscess of the lung, in cases of "uncertain" origin, often was derived from teeth or gums by aspiration. Of our 26 cases of acute abscess in which the etiology was "uncertain," 17 presented gross gingivodental infection. For the reasons advanced in Stern's paper, we concur in his view that these cases are of gingivodental origin. In 9 instances the etiology was entirely obscure and such cases are often referred to as of pneumonic origin. No differences in clinical course or in pathological features were discerned in these cases as compared with those of definite etiology. Furthermore, on x-ray examination the pulmonary infiltration which preceded cavitation was no more extensive than in cases of known etiology. For these and other reasons referred to elsewhere, we believe that pneumonia is not the etiological factor in acute abscess of the lung of obscure origin.

It would lead too far afield to discuss the varied etiology of the 45 cases in relationship to the question of the aspiratory versus the embolic theory of causation of putrid pulmonary abscess. However, an examination of the tabulation of the etiology of these cases indicates that embolism played no rôle with 1 (Case 45), or possibly 2, exceptions (Case 37).

An interesting sidelight on gingivodental infection as a cause of putrid abscess of the lung is offered by the fact that pulmonary abscess of "uncertain" etiology occurred among adults alone. In all of the children in our series, the cause of the pulmonary abscess was obvious. Since severe gingivodental lesions are encountered very rarely among children, the importance of the oral status in the etiology of abscess of the lung in adults becomes evident.

Roentgenographic features. The characteristic roentgenogram of the chest in cases of acute abscess discloses a single localized cavity in the lung, with a well defined fluid level, and a surrounding narrow zone of pulmonary infiltration. However, considerable variation from the typical picture is often seen. Thus, the abscess cavity may be filled completely with pus and detritus, and no fluid level may be visible. In such instances the shadow cast by the filled cavity merges with, and is indistinguishable from, the surrounding pulmonary infiltration. As a result, there is a fairly dense shadow like that of pneumonic consolidation. At times small areas of rarefaction may be noted in the midst of this infiltration. In other instances there is a wide, instead of a narrow, surrounding zone of increased density although a well defined cavity with or without a contained fluid level is seen. In such cases we have found that the abscess generally corresponds in size to that of the major portion of the area of "pulmonary infiltration" as noted on the roentgen film.

In only 7 of our 34 cases of non-perforated acute abscess of the lung, were the roentgenographic features typical in accordance with the definition contained in the first sentence of the preceding paragraph. In these 7 cases, the cavity ranged in diameter from about 2 to 4 inches. In the 27 remaining cases, the roentgen findings varied as follows: Extensive pulmonary infiltration without evidence of cavitation, 6 cases; extensive infiltration containing single or multiple areas of rarefaction, 19 cases; and extensive infiltration containing a single cavity 2 to 4 inches in diameter, 2 cases. It is significant, we believe, that these atypical findings were encountered most often in cases in which the clinical course was severe.

The characteristic roentgen film of perforated abscess of the lung is that of limited or widespread empyema or pyopneumothorax, more commonly the latter. Because of the comparatively large size and the density of the pleural effusion, the details of the causative pulmonary lesion usually are obscured. However, in 5 of our 11 cases the pleural lesion was so situated, in relationship to the pulmonary abscess, that both could be identified in the roentgen film.

Bronchoscopic examination.[1] The extraordinary accuracy of properly conducted diagnostic bronchoscopy is evident from an inspection of our case analyses, with particular reference to the operative findings. Bronchoscopy was performed in 20 of the 34 unperforated cases. In 17 of the 20, bronchoscopic examination located precisely the bronchopulmonary segment or segments in which the abscess was

[1]All bronchoscopic examinations are performed by members of the laryngological service of Dr. Rudolph Kramer.

situated. Among these the involvement of 2 or more contacting bronchopulmonary segments was revealed in a few instances. In 2 cases the abscess was shut off from the communicating bronchus; and in these, bronchoscopy confirmed the presumptive diagnosis of a "shut-off" lesion. The single error in localization of the abscess by bronchoscopy led to an operative approach at an incorrect site (Case 10).

The amount of foul pus encountered at bronchoscopic examination ranges from very small amounts to large quantities. The technique whereby the source of foul pus can be identified with precision, even when the bronchial tree on the involved side is more or less completely flooded, can be acquired only by those who are especially interested in, and frequently examine, such cases. Skillful bronchoscopic examination was particularly valuable in the diagnosis of 2 cases (Cases 9 and 22) in which the *sputum was not foul*, for it disclosed not only the presence but also the precise origin of *foul* pus.

Bronchoscopy is *not* indicated in cases of perforated abscess of the lung, because operation usually is imperative and localization of the lesion rarely offers difficulties. It was performed, however, in 1 of our 11 perforated cases, an instance in which the diagnosis of perforation was not made prior to operation.

Concerning the 14 unperforated cases of abscess of the lung in which diagnostic bronchoscopy was not performed, 9 of the patients were considered too ill for bronchoscopy, or were operated upon as emergencies. In 2 instances, an incorrect diagnosis of perforation into the pleura was made. In the 3 remaining cases precise localization of the abscess was simple, and the existence of a foreign body or an endobronchial lesion seemed quite unlikely.

Duration of illness. The duration of illness of the cases of perforated abscess now will be discussed. Before doing so we wish to emphasize that we are discussing only cases in which a substantial pulmonary abscess is present, and do not include cases of small "cortical" abscess with perforation. In the latter, the symptoms are essentially those of the complicating pleural infection and not those of pulmonary abscess. Thus, in the majority of our patients, the expectoration of foul pus and other manifestations of abscess of the lung continued after perforation had occurred. It can be stated at once that the diagnosis of perforation was found at operation to be incorrect in some of the cases, and, conversely, that pleural penetration was not suspected in some instances in which it was found at operation.

Of the 11 perforated cases, 2 had had symptoms of pulmonary abscess for less than 1 week before admission; 2 had been ill for 1 to 2 weeks; 4 had been ill for 2 to 3 weeks; and 3 had been ill for 4 to 5 weeks.

Seven were operated upon as emergencies on admission because the existence of perforation was recognized; 2 were operated upon in the first, and 2 in the second week of observation in the hospital. In 2 of the 11 cases (Cases 37 and 44), perforation occurred undoubtedly during the patient's pre-operative stay in the hospital.

An analysis of the known (or assumed) time of perforation in the 11 cases leads to some interesting conclusions. In 2 cases, perforation occurred in the second week, and in 6 cases in the third week of illness. Two others were known to have had pleural invasion in the third or, at the latest, in the fourth week; and in the last case, perforation *probably* occurred in the fourth week. In other words, perforation into the pleura occurred in the second or third week in most of the cases. A second conclusion to be drawn from our analysis is that the existence of *localized* perforation cannot always be recognized before operation. Finally, perforation can occur during hospital observation as well as before admission.

Of the 34 unperforated cases, the duration of illness before admission to the hospital was: up to 1 week, 2 cases; 1 to 2 weeks, 13 cases; 2 to 3 weeks, 7 cases; 3 to 4 weeks, 9 cases; 4 to 5 weeks, 2 cases; fifth week, 1 case.

The duration of illness during hospital observation before operation varied somewhat, but it will be noted that the great majority of the patients were operated upon in the first week of hospitalization. The figures are as follows: operation on admission, 3 cases; in the first week, 23 cases; in the second week, 6 cases; and in the third and fourth week, 1 case each.

GROUP B—ACUTE PUTRID PERFORATED ABSCESS OF LUNG

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
35 A.C. 1929 310,124 Female 5	Post-tonsillectomy (general anesthesia) 3 wks.	Fever and cough. *No sputum*	Encapsulated pyopneumothorax rt. chest between upper and lower lobes, 3rd and 4th ribs posteriorly	Not performed	Perforated abscess of R.L.L. Interlobar putrid pyopneumothorax Operated upon on admission	*One stage.* G-O-E anesthesia. Paravertebral approach through 4th rib after mobilization of scapula. Drainage of putrid pyopneumothorax. Unroofing of perforated abscess on under surface of upper lobe. Free pleura opened in order to unroof pulmonary lesion completely	Development of encapsulated non-putrid empyema cavities in posterior portion of pleural cavity. Two subsequent thoracotomies for drainage of empyema cavities. Course thereafter satisfactory. Discharged 3½ mos. after original operation	Uneventful. Bronchial fistula maintained for 2 mos.	Well. 7-year follow-up. Symptom-free. Negative x-ray
36 V.S. 1931 391,508 Male 32	Unknown 2 wks.	*Odorless* sputum. Symptoms those of very severe pleurisy. Septic temperature 100°–104°	2-in. localized area of infiltration lower portion of rt. lung. At lower level more extensive infiltration with a large fluid level. Marked thickening of pleura over the lower lobe	Not performed	Perforated abscess of R.L.L. Encapsulated putrid pyopneumothorax 1 wk.	*One stage.* Local anesthesia. Anterior axillary approach, through 5th rib. Drainage of putrid encapsulated pyopneumothorax. Perforated ¾-in. abscess of lung. Pulmonary and pleural lesions packed	Uneventful. Discharged from hospital 12 days after operation	Uneventful. Bronchial fistula maintained for several wks.	Well. 5-year follow-up. Symptom-free. X-ray negative
37 L.H. 1932 335,714 Male 15	Unknown 2 days	Typical of pneumonia of R.U.L. and R.L.L. with rapidly developing pleural effusion. Sputum *not foul*	Encapsulated pyopneumothorax posterior part of rt. chest, middle third. Oval cavity within the compressed lung near apex	Not performed	Multiple perforated and unperforated abscesses of R.L.L. Encapsulated putrid pyopneumothorax 11 days	*One stage.* Local anesthesia. Posterolateral approach, through 6th rib. Drainage of an encapsulated putrid pyopneumothorax. Perforated abscess of lung visualized. Directly above this was a rounded elevation interpreted as a nonperforated abscess. Foul pus encountered on aspiration. Lesion unroofed. Pulmonary and pleural lesions packed	Improvement for 4 wks., but cough continued and sputum became occasionally foul. X-ray revealed a new 1-in. cavity with fluid level near the hilum of the R.L.L. posteriorly		
						2nd operation. (5 wks. after 1st operation.) G-O anesthesia. Through existing wound lung was aspirated. Abscess found and unroofed	Aphasia, hemiparesis, and rt. homonymous hemianopsia present after operation. Spontaneous subsidence of all symptoms. Discharged 4 wks. after operation	Uneventful. Bronchial fistula maintained for 6 wks.	Well. 5-year follow-up. Symptom-free. X-ray negative
38 P.P. 1932 338,310 Male 36	Postacute follicular tonsillitis 3 wks.	Occasional foul odor of sputum. Rapid development of pleural effusion. Severe dyspnea and cyanosis	Large encapsulated pyopneumothorax posterolateral portion of rt. chest. Area of rarefaction in the underlying compressed lung in region of upper lobe	Not performed	Perforated abscess of R.U.L. Interlobar putrid pyopneumothorax Operated upon on admission	*One stage.* Local anesthesia. Posterolateral approach through 6th rib. Encapsulated putrid pyopneumothorax between the upper and lower lobes. Perforated abscess on under surface of upper lobe. Pulmonary and pleural lesions packed	Uneventful. Discharged from hospital 37 days after operation	Uneventful. Bronchial fistula maintained for 2 mos.	Well. 4¾-yr. follow-up. Symptom-free. X-ray negative

GROUP B—ACUTE PUTRID PERFORATED ABSCESS OF LUNG—Continued

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
39 C.H. 1932 345,222 Female 40	Indeterminate (poor oral and dental hygiene) 3 wks.	Typical of putrid abscess of lung with later development of severe pleural infection	Circumscribed area of pneumothorax middle third of rt. chest. Lung is infiltrated and compressed above this region. Infiltration in R.L.L. with small pleural effusion	Not performed	Perforated abscess of R.L.L. Encapsulated putrid interlobar and parietal pyopneumothoraces Operated upon on admission	*One stage.* Local anesthesia. High axillary approach through 3rd rib. Drainage of interlobar and parietal encapsulated pyopneumothoraces. Exposure of perforated abscess on upper surface of lower lobe. Pulmonary and pleural lesions packed	Uneventful. Discharged 16 days after operation	Uneventful. Bronchial fistula maintained for about 1 mo.	Well. 2-yr. follow-up. Symptom-free
40 B.L. 1934 376,988 Female 29	Postanesthetic (for therapeutic abortion) 3 wks.	Typical of putrid abscess of lung with development of severe pleural infection. Chronic rheumatic cardiovalvular disease. Mitral stenosis	Dense infiltration mesial portion of R.U.L. and R.L.L. Thickening of pleura along interlobar fissure. No abscess cavity visible	Not performed	Perforated abscess of R.L.L. Putrid encapsulated interlobar pyopneumothorax Operated upon on admission	*One stage.* Local anesthesia. Posterior approach through 7th and 8th ribs. Drainage of interlobar encapsulated pyopneumothorax. Exposure of perforated abscess on upper surface of lower lobe. Pulmonary and pleural lesion packed *2nd operation*, 2 days after 1st operation. *One stage.* Local and G-O anesthesia. Midaxillary approach through 8th rib. Large putrid pyopneumothorax evacuated	Cessation of cough and expectoration. Continuation of fever and dyspnea. X-ray 2 days after operation revealed an encapsulated anterior pyopneumothorax Improvement for 9 days. Then symptoms of cerebral embolus in rt. frontoparietal region. Gradual spontaneous recovery. Discharged 9 weeks after operation	Uneventful. Bronchial fistula maintained for 5 mos.	Well. 2½-yr. follow-up. Symptom-free. X-ray and bronchogram negative
41 A.R. 1935 382,256 Female 70	Unknown 10 days	Typical of putrid abscess of lung with early development of severe pleural infection	Generalized enlargement of heart. Pleural effusion—lower third of lt. chest. 1-in. cavity with fluid level in lung, situated posteriorly near lt. border of heart	Not performed	Perforated abscess of L.L.L. Putrid encapsulated posterior pyopneumothorax 3 days	*One stage.* Local anesthesia. Posterolateral approach through 9th rib. Drainage of posterior encapsulated pyopneumothorax. Unroofing of perforated lung abscess. Pulmonary and pleural lesions packed	Two episodes of coronary thrombosis and several small hemoptyses due to minor pulmonary infarctions	Uneventful. Bronchial fistula maintained for 3 wks.	Well. 1½-yr. follow-up. Symptom-free. X-ray negative
42 C.D. 1935 384,999 Female 35	Indeterminate (poor oral hygiene) 5 wks.	Typical of putrid abscess of lung with later development of severe pleural infection. Diabetes mellitus	Large pyopneumothorax rt. chest with 50 per cent collapse of lung. Abscess of the lung with small fluid level situated posteriorly	Not performed	Perforated abscess of R.L.L. Multiple encapsulated putrid pyopneumothoraces Operated upon on admission	*One stage.* Avertin, G-O anesthesia. Posterolateral approach through 8th rib. Drainage of multiple encapsulated loculations of putrid pus and air. Perforated abscess of lung exposed and widely unroofed. Pulmonary and pleural lesions packed	Uneventful. Discharged 7½ weeks after operation	Uneventful. Bronchial fistula maintained for 2 mos.	Well. 1½-yr. follow-up. Symptom-free. X-ray negative

GROUP B—ACUTE PUTRID PERFORATED ABSCESS OF LUNG—Concluded

Name, year, admission No. / Sex / age	Etiology / Duration before admission	Pre-operative course, special features	X-ray	Bronchoscopy	Location of lesion / In hospital before operation	Operative procedure and findings	Postoperative course (in hospital), special features	Later course	Result
43 G.K. 1935 385,770 Female 24	Post-tonsillectomy (local anesthesia) 4½ wks.	Typical of putrid abscess of lung with later development of pleural infection	Dense shadow over L.U.L. with fluid level in posterior axillary region	Not performed	Perforated abscess of L.U.L. Encapsulated posterolateral putrid pyopneumothorax Operated upon on admission	*One stage.* Avertin G-O anesthesia. Posterolateral approach through 4th and 5th ribs after mobilization of scapula. Evacuation of small encapsulated pyopneumothorax. Large perforated abscess of lung exposed, and unroofed. Pulmonary and pleural lesion packed	Satisfactory. Minor revision of wound 2 wks. later for more direct drainage. Discharged 43 days after operation	Uneventful. Bronchial fistula maintained for 6 wks.	Well. 1½-yr. follow-up. Symptom-free. X-ray normal
44 L.F. 1935 387,013 Male 63	Indeterminate (poor dental and oral hygiene) 1 wk.	Septic course, high fever, chills, rapid loss of weight, profound toxemia	1-in. x 2½-in. cavity with fluid level paravertebral segment of R.L.L. at level of 10th rib. Mottled infiltration throughout remainder of R.L.L. Considerable fibrinoplastic pleural exudate present	Large amount of thin, foul secretion all branches of R.M.L. and R.L.L. especially posterior branches of R.L.L.	Perforated abscess of R.L.L. Encapsulated putrid pyopneumothorax invading posterior mediastinum 13 days	*One stage.* Avertin oxygen anesthesia. Paravertebral approach through 11th rib and transverse process. Putrid pyopneumothorax, encapsulated in paravertebral region and invading the mediastinum, was entered and evacuated. Large perforated abscess exposed on paramediastinal aspect of R.L.L., and unroofed. Lesion in lung, pleura and mediastinum packed	Uneventful. Discharged 38 days after operation	Uneventful. Bronchial fistula maintained for 6 wks.	Well. 1½-year follow-up. Sympton-free. X-ray negative
45 R.P. 1935 386,552 Female 22	Induced abortion. Secondary septicemia 5 wks.	Septic fever, frequent chills. Marked dyspnea and cyanosis. Profound prostration. Foul smelling lochial discharge	Large left sided pyopneumothorax. ¾-in. cavity in left upper lobe. Dense infiltration in axillary portion of rt. lung. Annular shadow 1½ in. in diameter at level of 8th rib posteriorly. Another cavity with fluid level 1 in. in diameter above and lateral to 1st cavity	Not performed	Perforated abscess of L.U.L. Large putrid pyopneumothorax. Multiple unperforated abscesses R.L.L. Operated upon on admission	*One stage.* Local anesthesia. Posterior axillary approach through 7th rib. Very large putrid pyopneumothorax evacuated. Perforated abscess mesial aspect of upper lobe at level of 4th rib anteriorly. Bronchial fistula present. Pulmonary and pleural lesions packed	Spontaneous disappearance of unperforated abscesses in rt. lung. Discharged 25 days after operation with bronchial fistula closed. Culture of pus from pyopneumothorax-anaerobic strept. of Schottmueller and anaerobic Strept. viridans. Culture of lochial discharge—B. coli and anaerobic Strept. viridans	Uneventful. Wound healed in 5½ wks.	Well. 1½-yr. follow-up. Symptom-free

Finally, the figures for the total duration of illness before operation are as follows: up to 1 week, 1 case; to 2 weeks, 4 cases; to 3 weeks, 10 cases; to 4 weeks, 7 cases; to 5 weeks, 7 cases; to 6 weeks, 5 cases.

The comparatively short duration of illness before admission in the majority of the cases, together with the necessity of early operation in most instances, are indices of the severity of the illness in the preponderance of patients in this series. Of the small group of patients operated upon toward the end of the 6 week period of total illness, some came to operation because of persistence rather than severity of symptoms. In others, the postponement of operation until the sixth week was due to the incorrect assumption of satisfactory progress.

Pre-operative course. In the common or so called "typical" case of acute abscess, the clinical manifestations are mild or moderately severe. Thus, the temperature averages around 100 to 101.5 degrees, and cough is moderate. Expectoration is foul, sputum averages about 4 ounces daily and is blood-streaked from time to time. The general condition is apt to remain fairly good. Of our 34 unperforated cases, only 11 conformed essentially to this clinical picture. In 4 others the clinical course, although only moderately severe, was complicated by episodes of frank hemoptysis. In the 19 remaining cases the manifestations were severe, the clinical course being classified as fulminating in 4, septic in 10, and toxic in 5. The 4 fulminating cases had spiking temperature ranging from 101 to 105 degrees, severe chills (in 3 of the 4), pulmonary excavation extended rapidly, and the general clinical course was one of rapid deterioration. In the 10 cases characterized as septic, pulmonary excavation was also extensive and progressive, fever was high and irregular, but there were no chills and deterioration was not so rapid. The 5 toxic cases ran fairly high fever; however, the outstanding clinical feature was profound prostration and apathy.

A complete analysis of symptomatology will not be given in this paper. However, because of its diagnostic significance, reference should be made to the variations which occurred in one of the important manifestations of the disease, namely, the sputum. As stated previously, the sputum in "typical" cases is foul, is slightly bloodstreaked from time to time, and averages about 4 ounces daily. Of the 34 unperforated cases, 19 had typical sputum. The remainder presented the following variations: unusually profuse sputum (20 to 30 ounces per day) in 6, unusually profuse but odorless in 2, foul but very scanty in 1, large hemoptyses on one or more occasions in 6.

The pre-operative course in each of the 11 *perforated* cases was that of the severely toxic or septic type of putrid pulmonary abscess. There were no mild cases. A discussion of the phenomena which characterize perforation, and of the diagnostic criteria of pleural invasion, will not be presented in this paper. However, a few facts gleaned from an analysis of our cases may be stated. The outstanding clinical feature of perforation into the pleura is not only an ominous change in the condition of the patient, but also the suddenness with which it occurs. The physical signs suggestive of fluid, or of fluid and air in the pleura, are definite aids in the diagnosis and are to be contrasted with the vague physical signs usually present when the abscess is confined to the lung. It is assumed by many that the expectoration of foul sputum ceases when an abscess perforates into the pleura. While this may be true in the case of perforation of a small cortical abscess, it is not the rule in rupture of the comparatively large abscess which is the subject of this paper. Thus, the expectoration of foul pus continued in 8 of our 11 cases.

Indications for operation. Early in our experience, operations were performed for acute putrid abscess of the lung solely because of imperative indications. In recent years, however, the indications for operation gradually have been broadened so that at the present time there exist, in our opinion, elective as well as imperative indications.

Operation was imperative, by any criteria, in about one-third of the unperforated cases. Thus, there were 11 cases in which an operative attempt at saving of life appeared urgent, because of a hyperacute, fulminating course with or without chills, or a course characterized by severe toxemia and profound asthenia. In the 11 cases of perforated abscess of the lung, operation was obviously imperative.

There remain 23 cases of unperforated abscess in which the indications for operation were considered "elective." Assuredly, a difference of opinion concerning these cases will exist, the generally held view being that abscess of the lung in the acute stage is a non-operative lesion. Although emphasizing that we do not operate in cases of acute abscess of the lung when the lesion is small and the clinical course satisfactory, we wish to state that our operative indications have been widening as the result of increasing confidence in the outcome of operation when performed with the technique we have developed. In our opinion, the elective operative indications to be mentioned are tenable only upon application of the principle of accurate pre-operative localization of the lesion and the use of the type of operative procedures which we advocate. We do not hesitate to express the opinion that high mortality and morbidity, as well as incomplete results, are almost inevitable if methods generally employed at present time in surgical treatment of abscess of lung are applied to cases of acute abscess.

With due regard to the statements contained in the preceding paragraph, our elective indications for operation are: (1) a septic or severely toxic clinical course (bordering on imperative indication); (2) the absence of a tendency toward spontaneous subsidence; (3) an apparently stationary lesion, as noted in successive roentgenograms, coupled with a moderately severe clinical course; (4) an increase in size of the lesion accompanied by increasing clinical manifestations; (5) a more or less "shut-off" lesion, or the development of a more or less "shut-off" state in a previously "open" lesion; (6) a dangerously situated lesion, in the "cardiac" lobe, for example; (7) unusually large lesions; (8) the roentgenographic evidence of pronounced pleural reaction suggesting impending or actual perforation of the abscess.

With increasing experience, we have become less and less inclined to defer operation if there is doubt as to the satisfactory progress of a case.

THE OPERATION

An outline of the operative procedures which were employed in our 45 cases will be found in the appended tabulation. The details of technique of operation have been described elsewhere,[1] and will not be discussed in this paper. However, reference will be made to certain aspects of operation which, in our opinion, have a significant bearing on the results.

Whether the choice of *anesthesia* is a factor in the results which have been obtained cannot be ascertained from a study of our cases. Thirteen of 34 operations for unperforated abscess were performed under local anesthesia. The remainder were carried out under gas-oxygen anesthesia (rarely with the addition of ether). In recent years avertin, supplemented when necessary by gas-oxygen, has been employed. On the other hand, local anesthesia has been used more often than general in the perforated cases.

The reasons for our advocacy of the *one stage operation* have been fully set forth elsewhere. Of the 38 operations (34 patients) for unperforated abscess, 34 were one stage procedures. In 2 instances (Cases 7 and 9), two stage operations were performed because the abscess, situated on the under surface of the lower lobe, faced the diaphragm. The 2 remaining patients (Cases 5 and 33), early in our experience were operated upon in 2 stages because the free pleural cavity had been opened by accident, adjacent to adhesions, at the first stage. (At the present time these 2 cases would probably be operated upon in one stage. All the perforated cases were operated upon in one stage.) Later drainage of secondary loculi was carried out in 3 instances, to which reference will be made.

The localization of the site of the abscess by pre-operative studies was the sole guide to the placement of the *thoracic incision*. As has been indicated elsewhere, we advocate no "standard" or "routine" approach. Thus, of 38 operations (34 patients) for unperforated abscess, an axillary approach was made in 6, anterior thoracic in 2, paravertebral in 16, posterolateral in 10, and anterolateral in 4.

The subject of *adhesions overlying the abscess* appears to be the most debated aspect of presentations on abscess of the lung which we have made at various times and places. This

[1]Surg., Gynec. & Obst., 1936, 63: 353–368.

analysis of operative cases of *acute* abscess offers the evidence in a comparatively small series. Additional supportive evidence is offered, however, by the findings in a much larger number of cases of *chronic* abscess. Accordingly, we maintain that overlying pleural adhesions are an inevitable accompaniment of putrid abscess of the lung. Adhesions were found at operation in every case of unperforated acute abscess, regardless of how early in the course of the disease operation was performed. Furthermore, the adhesions were sufficiently firm and widespread to agglutinate the apposed pleural surfaces, and thereby permit safe entry of the abscess in one stage. (Cases 7 and 9 are exceptions for obvious reasons.)

However, the operative exposure of adhesions sometimes was not a simple matter, and it is probably because adhesions are not always disclosed at the primary incision of the pleura that many observers have questioned our contention that adhesions always are present. Despite painstaking attempts at precise localization, adequate agglutinating adhesions were not found at the site of initial rib excision in all of our cases. Analyzing the 38 operations, adhesions occupying the entire operative field, to the complete exclusion of the free pleura, were encountered in 27. In 7 others, because of slight errors in localization or in placement of the incision, adequate adhesions were found not directly beneath, but immediately adjacent, to the primary operative exposure. (As stated in our previous communication, the entry of the free pleural cavity, directly adjacent to adhesions, no longer constitutes a bar to the performance of a single stage procedure.) There was one gross error in localization, already referred to, and in this case (Case 10), no adhesions were found at the site of operative approach. The absence of adhesions was recognized, and accordingly the pleura was not opened. Adequate adhesions were encountered at a second operation, when the operative approach was made at the correct site a few days later. Disclosure of adhesions, in or adjacent to site of operative approach, at 34 of 35 operations (31 patients), is the best commentary on the accuracy with which acute abscess of the lung can be localized.

Well developed adhesions also existed in the 3 remaining cases, but were not parietal and therefore could not possibly be present at the site of operative approach. In 1 of these (Case 9), the abscess faced an interlobar fissure. In this instance, the adhesions agglutinated the apposed surfaces of the lobes and sealed the fissure about the abscess. In the last 2, the abscess faced the under surface of the lower lobe. In this region, agglutinating adhesions were situated between the under surface of the lobe and the adjacent surface of the diaphragm. This picture presented itself in our Cases 7 and 21.

In the 11 perforated cases, adhesions lying directly over the abscess were of course destroyed in the process of penetration of the abscess into the pleural cavity. It is interesting to note, however, that some attachment of the lung to the parietes in the region of the abscess still persisted in a number of cases at the time of operation.

Entry of the free pleural cavity. The free pleural cavity was entered inadvertently at only 1 of the 27 operations *in which there were parietal pleural adhesions at the site of operative approach.* In this instance (Case 15), in which a child was operated upon under light general anesthesia, the pleura tore, apparently as the result of the patient's straining, after the abscess had been incised. The free pleural cavity was entered inadvertently shortly after rib excision in 4 cases (Cases 5, 14, 20, and 30) and this *was attributable to faulty technique.* (However, the fact that the pleural cavity could be entered so readily was evidence also that there were no adhesions or only scanty adhesions at the immediate site of the primary operative approach.) The pleural opening at once was enlarged in these cases for purposes of exploration.

The free pleural cavity was entered intentionally in 7 cases. Reference already has been made to 3 of these (Cases 7, 9, and 21), in which no parietal adhesions were present because the abscess faced the interlobar fissure or the diaphragm. In the 4 other cases (Cases 13, 24, 32, and 33), the free pleural cavity was opened in order to search for adhesions which were absent at the immediate site of operative exposure.

It should be especially stressed that the pleural entry, whether planned or accidental, took place early in the course of operation (with the single exception already noted—Case 15). Because of this fact there was but one complicating putrid empyema following an operation for unperforated abscess (Case 9), and this occurred after the first stage of a deliberately performed two stage operation.

Some features of the pathology at operation. The superficial situation of the lesion within the lobe of the lung, a fundamental characteristic of putrid abscess which was pointed out in a former communication,[1] goes hand in hand with the presence of overlying pleural adhesions. In each of the 34 unperforated cases, the abscess was entered after traversing a practically avascular shell of compressed lung which measured about one-quarter of an inch in thickness. The superficial situation of the pulmonary lesion in perforated cases is self-evident, and probably constitutes the most important reason for the occurrence of early perforation.

One of the arguments which we advanced in favor of operation in the acute stage of putrid abscess of the lung, was the tendency of the lesion in many of the more severe cases to assume, at a comparatively early date, some of the pathological features of chronic abscess. Thus, of our 34 unperforated cases, only 18 (little more than half) presented the solitary, unilocular cavity which is characteristic of the early acute phase. Of the lesions in the 16 remaining cases, 8 were distinctly bilocular and 8 were multilocular (not multiple). In each of the 11 perforated cases, the lesions were unilocular. This perhaps was to be expected because early evacuation of the abscess into the pleura probably reduced the likelihood of further extension of the lesion within the substance of the lung.

The only additional feature of the pathological findings at operation, to which we shall refer here, is the bronchial fistula. One or more freely blowing fistulas was found opening into the cavity in every case. In a few instances in which the fistula was not apparent at operation, because it was plugged with detritus or blood, it was seen at the first dressings.

[1]Loc. cit.

Postoperative complications. The clinical course of our 45 patients, from the time of operation to the time of discharge from the hospital, can be analyzed briefly. In 28 cases, recovery was uneventful. In the 17 remaining (13 unperforated and 4 perforated), the postoperative course presented complications of varied nature and severity. For the sake of completeness all are included, although several were of a minor nature, others existed prior to operation, and still others appeared to be independent of the operative procedure.

The complications in the 34 unperforated cases (38 operations) were as follows: toxic psychosis, 2 cases; undrained adjacent abscess, 2 cases; undrained adjacent abscess with toxic psychosis, 1 case; sterile hydropneumothorax and toxic psychosis, 1 case; mild bronchopneumonia (non-putrid), 1 case; spillover putrid lung abscess, 1 case; thrombophlebitis of a branch of the pulmonary vein, 1 case; bleeding from the wound at the first dressings, 2 cases. None of these complications was fatal, and few were serious in the sense that they endangered life. Two deaths occurred after operation. These will be discussed separately.

The 4 complications in the 11 perforated cases were as follows: bland cerebral embolus with spontaneous recovery, 2 cases; coronary thrombosis and pulmonary infarction, 1 case; and multiple encapsulated non-putrid empyemas, 1 case. There were no deaths in the perforated group.

Discussion of deaths. As stated in the preceding section, there were 2 deaths in the series, both occurring in unperforated cases. In 1 case (Case 9), the patient had a single abscess which lay partially within the right middle and partially within the right lower lobe as the result of extension across the sealed-off interlobar fissure. Because of the unusual location of the lesion, adhesions were present only between the middle and lower lobe, and between the lower lobe and the diaphragm, there being no parietal adhesions of the lung to the chest wall. For this reason a two stage operation was undertaken. Between the first and the second stage, the patient developed evidence of pleural infection, toxic psychosis (and cerebral embolism?). In

spite of drainage of the abscess at the second stage, and subsequent drainage of the pleural infection, the patient died. At postmortem examination, the lesions found within the right lung and pleura were sufficient to account for death, but whether a cerebral embolus also existed was not determined because of a limited autopsy. This case represents a surgical death which occurred early in our experience, and which we regard as probably avoidable with present surgical methods.

As to the second fatal case (Case 28), the patient was admitted to the hospital 9 days after incision, without anesthesia, of a peritonsillar abscess. Cough and profuse foul expectoration had been present for several days prior to admission, but the unusual clinical feature was a septic course with irregular, spiking temperature and repeated, severe, shaking chills. On admission, the patient was suffering from profound toxemia and toxic psychosis. Successive x-ray films taken before admission revealed a rapidly enlarging abscess involving much of the right lower lobe. The repeated chills and profoundly septic state led to the additional diagnosis of septic thrombophlebitis of a large branch of the pulmonary vein. This appeared to be the most ominous feature of the case. At operation, on the day after admission, a huge pulmonary abscess was evacuated, unroofed, and packed, in one stage. The operation was without incident. Cough and foul sputum ceased, but septic fever and chills continued, and death occurred on the fourth day after operation. The assumption is warranted that in this instance, death was due to a continuation of sepsis and not to operation.

Secondary operations. In a number of cases, secondary operations, ofttimes minor procedures, were performed for various purposes. In the unperforated group, there were 4 cases in which drainage of additional loculi was performed (Cases 3, 14, 20, and 30), the drainage being established through the existing operative wound in 3 of the 4 cases; a putrid empyema was drained in 1 case (Case 9, the fatal case already referred to); plastic operations for early closure of large cavities were carried out in 3 cases (Cases 15, 22, and 27). It should be noted that the latter were operations of choice, performed for the purpose of shortening the duration of open wounds.

In the perforated group, additional undrained pleural collections were operated upon in 2 instances (Cases 35 and 40); an additional unperforated abscess of the lung was drained in 1 case (Case 37); and minor revision of an existing surgical wound was performed in order to permit more direct drainage in 1 case (Case 43).

Duration of postoperative hospitalization. There is a rather widely held view that serious complications often follow operation for abscess of the lung, and that the period of postoperative hospitalization is inordinately long. The fact is, as already pointed out, that serious postoperative complications were rare. As a corollary, the postoperative stay in the hospital usually was not unduly prolonged. Of the unperforated cases, more than half left the hospital in the first month after operation and most of the remainder left in the second month. The stay of the perforated cases was longer, in a few instances, because of treatment required for large empyema cavities.

Duration of maintenance of bronchial fistula and open wound. The management of the bronchial fistula, a vital part of postoperative treatment, has been discussed elsewhere.[1] The point to be stressed is that closure of the bronchial fistula, always present after an adequate operation for abscess of the lung, should be under control of the surgeon. The fistula is then permitted to close only after all clinical evidence of anaerobic infection has disappeared, after pulmonary infiltration is no longer visible in the roentgenogram, when expectoration is absent or minimal and, if doubt exists, after bronchoscopy has been performed with negative findings.

It has been asked whether difficulty ever has been encountered in closing the bronchial fistula. Difficulties are encountered occasionally in cases of chronic abscess of the lung when one or more fistulas have been present for a considerable period of time. After operation for acute abscess of the lung, however, the problem is not how to close, but rather how to keep open, a fistula which tends to close prematurely. In the majority of our

[1] Loc. cit.

cases, fistulas were permitted to close within 8 weeks of operation. Since these fistulas were purposefully maintained by packing or by tube, the wounds closed in all cases soon after drains were discontinued. There were 3 patients in whom fistulas were maintained for long periods—7 months, 1 year, and 2 years, respectively. In the first, the cavity was of unusually large size and was obliterated slowly. The second patient insisted upon wearing his tube for a year because he had had recurrence of manifestations when his fistula was permitted to close shortly (prematurely) after operation. In this case, there remains a cutaneous dimple into which a fine probe can be introduced. Because of an oversight, the bronchial fistula was maintained by a tube for 2 years in the third case. It is of interest to note that the wound closed promptly after the tube was removed.

Bronchial fistulas also were present in all of the perforated cases after operation. Fistulas were maintained for periods up to 5 months, the average being about 7 weeks. The wounds generally were closed within a few weeks of the time of bronchial closure. As in the unperforated cases, the wounds closed completely in all cases.

Results of treatment. In evaluating the results of treatment, our criteria of cure are strict. No patient is considered cured unless pulmonary symptoms have disappeared completely, pulmonary infiltration is absent on roentgenographic examination, and the wound is healed. Bronchoscopy and bronchography, if performed, also must be negative. Cure, according to these criteria, usually occurs early and is lasting. There were 2 deaths to which reference already has been made. Of the 43 remaining patients, 32 were in the unperforated group and 11 in the perforated.

Of the 32 unperforated cases, 29 were followed for periods ranging from 1 to 10 years. Complete cure occurred in all. (In Case 4, death occurred from carcinoma of the stomach 3 years after operation, and the lungs were negative at postmortem examination.) The 3 remaining cases were doing well and apparently progressing toward cure when their follow-up was terminated as follows: 1 case, after 4 months, suicide; 1 case, after 3 months, death following operation for strangulated hernia; 1 case, after 3 months, disappeared from observation. The last was the only instance in which our follow-up has been incomplete.

The 11 perforated cases have been followed for periods ranging from 1½ to 7 years. All are cured.

SUMMARY

Forty-five consecutive operative cases of acute putrid abscess of the lung, treated in accordance with principles described by the authors in another communication, are analyzed. In 34 cases the abscess was confined to the pulmonary parenchyma. In 11 cases the abscess had perforated into the pleura prior to operation.

A single abscess was present in the great majority of cases. The right lung was involved more than twice as often as the left. These facts, in addition to others stated in the text, tend to support the aspiration theory of causation of pulmonary abscess.

The etiology was definite (tooth extraction, tonsillectomy, etc.) in 19 cases. It was entirely obscure in 9. The 17 remaining patients suffered from gross gingivodental infection which, for reasons stated in the text, was regarded as the source of the pulmonary abscess.

The typical roentgenographic features of acute abscess of the lung were present in the minority of cases. Atypical features were encountered most often in the severe cases.

Diagnostic bronchoscopy located with great accuracy the bronchopulmonary segment or segments in which the abscess was situated.

The duration of illness before hospitalization varied from several days to 5 weeks, the majority of patients entering the hospital in the second to fourth week. The complication of perforation of the abscess into the pleura took place most commonly in the second or third week of illness. The relatively short duration of illness before admission, in the majority of cases, together with the necessity of early operation in most instances, indicated the severity of the disease in the preponderance of patients in this series.

Typical clinical manifestations of acute putrid abscess of the lung occurred in only 11 patients. Hemoptysis was an outstanding feature in 4 cases. The clinical course was

fulminating in 4, septic in 10, and toxic in 5. It was of the severely toxic or septic variety in all cases of perforated abscess.

The outstanding clinical feature of perforation into the pleura was not only an ominous change in the condition of the patient, but also the suddenness with which it occurred. The presence of physical signs of empyema or pyopneumothorax was a definite aid in the diagnosis of perforation, and contrasted with the indefinite physical signs usually found in unperforated abscess of the lung.

Although operation is not advocated in acute abscess when the lesion is small and the clinical course satisfactory, the authors' operative indications have been widening. As a result, elective as well as imperative operative indications are described. Operation was classified as imperative in all perforated cases because severe and ofttimes spreading infection existed, and spontaneous recovery seemed most unlikely. In 11 unperforated cases, operation was imperative because the course was fulminating and hyperacute, or was characterized by severe toxemia. In the 23 remaining unperforated cases, the indications for operation were elective. The authors' elective indications are: (1) septic or severely toxic clinical course (bordering on imperative indication); (2) absence of any tendency toward spontaneous subsidence; (3) apparently stationary lesion (in successive roentgenograms) coupled with a moderately severe clinical course; (4) increase in size of the lesion accompanied by increasing clinical manifestations; (5) more or less "shut off" lesion, or the occurrence of a more or less "shut off" state in a previously "open" lesion; (6) potentially dangerous situation of the lesion, in the cardiac lobe for example; (7) unusually large lesions; (8) roentgenographic evidence of pronounced pleural reaction suggesting impending perforation of the abscess.

With 4 exceptions, all operations were performed in one stage. The one stage operation is advocated by the authors only when the exact localization of the abscess by pre-operative studies has been carried out. The principles of operation consist essentially in the unroofing and the wide packing of the abscess cavity.

Pleural adhesions overlying the abscess invariably were present, regardless of how early in course of the disease operation was done.

In 38 operations (34 patients) for unperforated abscess, adequate adhesions occupying the entire operative field at the initial site of rib excision were encountered 27 times. In 7 others, adhesions were found immediately adjacent to the primary operative exposure. In 1 case, no adhesions were found at the initial operative site because of an error in localization. In the 3 remaining cases adhesions, although well developed, were not situated parietally because of the unusual location of the abscess (interlobar, supradiaphragmatic, etc.).

The free pleural cavity was entered inadvertently during only 1 of the 27 operations in which there were parietal pleural adhesions at the site of operative approach. Of the remaining cases, the free pleura was entered accidentally, shortly after rib excision, in 4 cases. It was opened in 7 cases for purposes of exploration.

In all cases, only a thin avascular shell of lung lay between the most superficial portion of the abscess and the overlying sealed off pleura. In 18 cases, a solitary unilocular cavity, characteristic of the early acute phase, was encountered. In 16, the cavities were already bilocular or multilocular. In each perforated case, the pulmonary lesion was unilocular. Bronchial fistulas were present in all cases.

Recovery was uneventful in 28 cases. In 17, there were complications which, for the most part, were not serious. Bronchial fistulas were permitted to close only after all discernible evidence of infection had disappeared—8 weeks in the majority of cases.

There were two postoperative deaths. One was due to pleuropulmonary suppuration. The second was due to the continuation of a sepsis which existed prior to operation. Of the 43 remaining patients 40 were cured according to the criteria stated in the text: (1) healed wound; (2) freedom from pulmonary symptoms; (3) absence of roentgenographic evidences of pulmonary infiltration. In the 3 remaining cases, the period of follow-up was too short to speak of cure, but all were progressing toward cure when last examined.

A STUDY OF HYPEREMESIS GRAVIDARUM WITH SPECIAL REFERENCE TO BLOOD CHEMISTRY

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IT is generally agreed that hyperemesis gravidarum is an exaggerated or pernicious form of "morning sickness" or nausea and vomiting of pregnancy. Its etiology is not known and although our methods of treatment have gradually improved we have no way of determining which patients will fail to respond to treatment. A critical study of the usual response to treatment may throw some light on these cases.

Generally the cases are classified as neurotic, reflex, and toxic. Many investigators believe that the neurotic type will respond readily to treatment whereas the toxic type does not. Solomons, as well as most present day writers, does not believe in the reflex type and he utilizes the Fouchet test[1] to distinguish the toxic from the neurotic. If the Fouchet test is positive, provided there is no albumin in the urine, the case is considered toxic and if the test is negative, the case is classified as neurotic. Van Wyck states that no satisfactory distinction can be made between the toxic and the neurotic vomiting. Plass considers them all neurotic and states he does not know how to differentiate those individuals who will die. Because so many patients respond to suggestive therapy it is natural to suppose that some or all are neurotic. Stander believes that from a clinical study and chemical findings in the blood and urine as well as from experimental work on animals, all cases of vomiting of pregnancy have a toxemic basis. The underlying toxemia may be obscured by a predominating neurosis. Accordingly we classify all cases of hyperemesis gravidarum with the toxemias.

There were 86 patients with hyperemesis gravidarum admitted to the New York Hospital in 12,005 admissions—an incidence of 0.71 as compared to 1.21 of Cruickshank, 0.5 of Costa, and 0.66 of Peckham. According to Pick, 1 in 1,000 and according to Williams 1 in several hundred pregnant women develop hyperemesis.

In this series were included only those patients who were admitted to the wards during their pregnancy and sufficiently studied as to weight, blood chemistry, and water balance—50 in all. Three of these had two admissions and 1 had four admissions. The cases were not divided as to severity. All cases in which patients required hospitalization were considered severe enough to be included in the study. The various theories as to etiology and treatment will not be considered.

The average age was 27.9 years (Fig. 1). There were a greater number of primiparæ but no increase in elderly primiparæ. The multiparæ averaged 1.48 children. Quigley found no increased nausea and vomiting in elderly primiparæ, and Misset found no difference in incidence between primiparæ and multiparæ, but he did find that with nausea and vomiting in the first trimester the incidence of late toxemia increased. Schultze-Rhonhof and others (8) find primiparity a definite factor.

There were only 2 negroes, 1 Porto-Rican, and 1 Mexican in our series. The average number of colored patients in the entire clinic is only 12.1 per cent (19). In a group from Baltimore (26) hyperemesis was equally divided between black and white. Theobald points out the rarity of toxemias of pregnancy in Siam and other countries in the far East. Holman, in reviewing the literature concerning hyperemesis gravidarum among various classes, notes that there is little evidence of this condition among the aborigines or so called uncivilized people.

The period of vomiting before entering the hospital varied from a few days to 7 months. However, with severe vomiting it was necessary that the patient enter the hospital within

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[1]An oxidation test for bilirubin. Compt. rend. soc. de. biol., 1917, 80: 826.

TABLE I

	Non-Pregnant	Normal pregnant 3rd month	At term
Non-protein nitrogen	33	30–31	28
Uric acid	3·5	3·3	3·3
CO_2 combining power volumes per cent.	65	55–60	45
Sugar	75	75	75
Sodium chloride	485	485	485–495

1 to 2 weeks. The patient with vomiting of 7 months, on admission had no acetone in the urine, a hemoglobin of 70 per cent, and remained only 6 days. Occasionally patients vomit intermittently throughout pregnancy without the necessity of entering the hospital. In general, the length of time in which vomiting had persisted before the patient entered the hospital had no definite relation to the severity of her condition nor to the response to treatment. This agrees with recent reports (26).

The average duration of pregnancy on admission was 13.9 weeks and only 63.8 per cent were 3 months and under. This was due to the long duration of vomiting in many cases.

The blood pressure was not materially affected. There was a tendency for the pressure to be slightly lower after treatment, although in numerous cases there was some increase. There was a distinct rise to 146 systolic in 2 cases of low reserve kidney and in 2 cases of late vomiting of pregnancy.

The hemoglobin was definitely increased on admission. In most of the severe cases it was 90 per cent or above (Sahli method used). The average was 87.3 per cent. After treatment there was a drop to an average of 76.5 per cent. The increased hemoglobin was no doubt due to the marked dehydration and concentration of the blood. This appears to be of some diagnostic significance as to the severity of the symptoms but by no means is it always indicative. Some patients with a hemoglobin of 90 to 95 were cured merely by frequent small meals and in 1 patient with an admission hemoglobin of 90 it was necessary to induce abortion. Generally when the hemoglobin was low, it denoted less dehydration and the symptoms were readily amenable to treatment.

The value of blood chemical findings is not fully appreciated. They are often said to be of little use in hyperemesis gravidarum. Yet

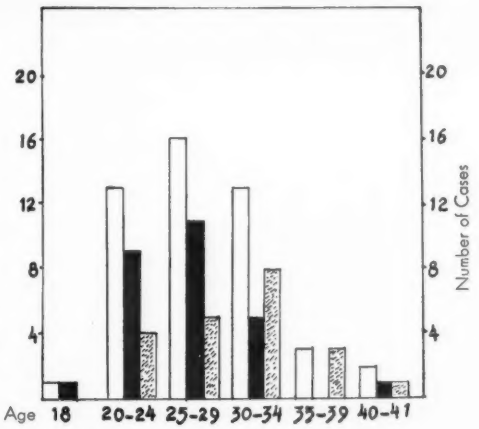


Fig. 1. Chart showing age and parity.

frequently one obtains valuable information and assistance in properly treating individual cases. Many reports are based on a single or admission determination. Most of our patients have repeated or serial determinations which allow a better picture of the progress and response to treatment.

In normal pregnancy there is an alteration in the metabolism and in certain of the blood constituents. The normal values as determined by Stander are shown in Table I. In hyperemesis there is a further change.

Harding (9), Dieckmann and Crossen, Haden and Guffy, Stander and others (5, 15), have found an increased non-protein nitrogen and uric acid in cases of vomiting, especially in the severe cases. By taking serial blood specimens and plotting curves, there is found to be a more or less definite drop following active treatment with fluids (Fig. 2). This is sometimes preceded by a short rise. In cases in which only dietetic measures are used, the drop is not so noticeable. The average non-protein nitrogen (Fig. 3) was 28.6 and the average after the initial drop was 24.6. Some patients in the later months of pregnancy, and possibly before abortion, have a rising curve in spite of active treatment. This is more noticeable in the uric acid curve than in the non-protein nitrogen (Fig. 5).

The uric acid usually follows the non-protein nitrogen (Figs. 2 and 4). Some of the

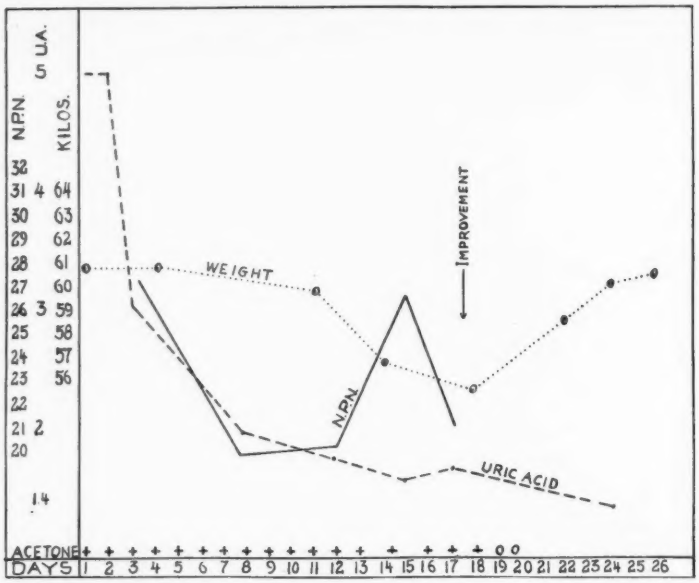


Fig. 2. Showing the usual early drop in non-protein nitrogen and uric acid. Note the disappearance of acetone in the urine and the rise in weight with improvement. Case No. 68307.

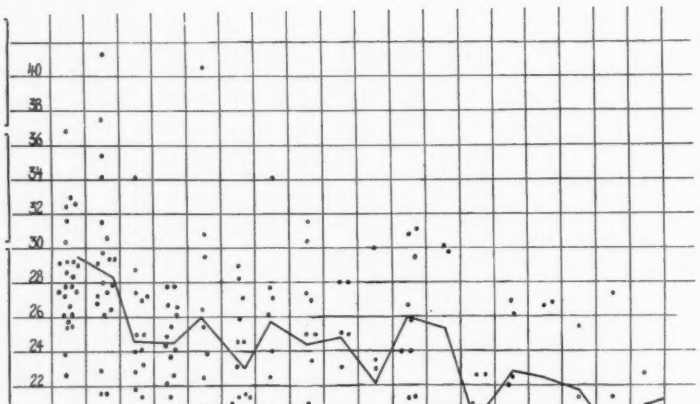


Fig. 3. A composite curve of the non-protein nitrogen. The early drop is not as conspicuous as is found in many of the individual cases.

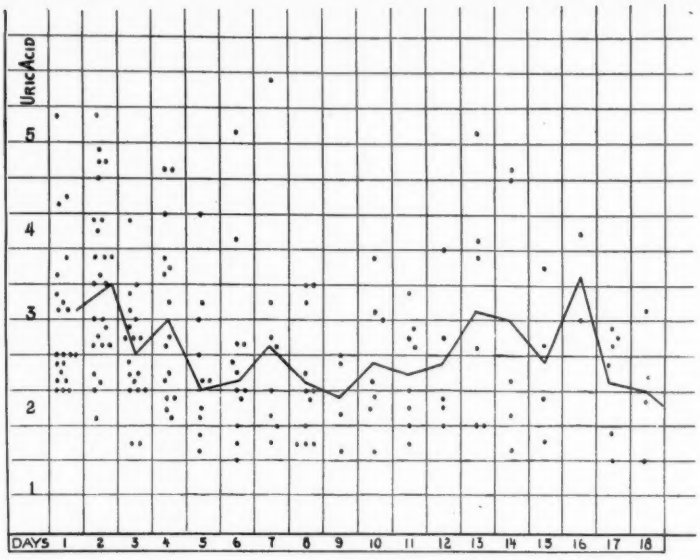


Fig. 4. A composite curve of the blood uric acid determinations. This does not depict the early drop as is shown in many of the individual cases.

cases had very little change but, except for an initial small rise, the majority have a distinct fall. It appears that in some cases which will not respond to treatment (Fig. 7) and in certain cases of late vomiting of pregnancy (Fig. 5) the uric acid tends to rise. In the latter cases it may indicate liver damage or even a mild yellow atrophy. Harding and Van Wyck (10), however, suggest that the vomiting of late pregnancy may have its origin in some salt and water disturbance, both sodium bicarbonate and sodium chlorides causing redistribution of water.

Low sodium chloride values are reported in hyperemesis by Stander (40), Harding (9), Haden and Guffy, and Dieckmann and Crossen. In the present series the average sodium chloride on admission was 489 which is essentially normal (Fig. 8). There was some tendency to an increase but the change was not great. One case had an extremely low sodium chloride, 365. One had 427 and another 435. Peckham reports an average of 480.9 and 2 patients with less than 400. Haden and Guffy report a case with blood chlorides of 300 and Harding and Van Wyck (12) report a case with blood chlorides of 290, both responding to sodium chloride therapy. This in itself reveals the value of blood chemical studies in the treatment of individual patients.

The blood sugar (Fig. 9) was fairly constant and apparently agrees with that of most investigators who find a normal or slightly lowered blood sugar (4, 6, 37), Peckham finds

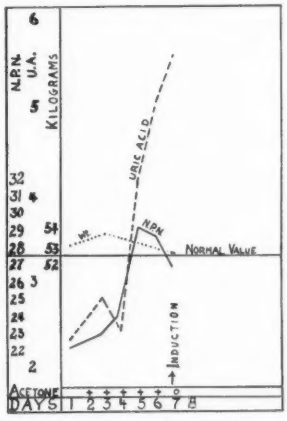


Fig. 5. Shows rising non-protein nitrogen and uric acid in late vomiting of pregnancy despite active treatment. Labor was medically induced 2 weeks before term. Case No. 42822.

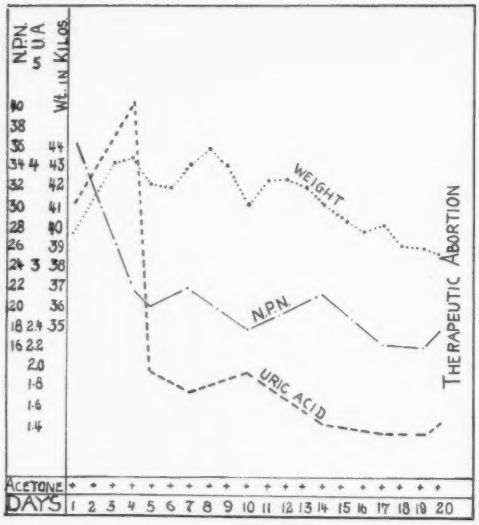


Fig. 6. Although the non-protein nitrogen and uric acid respond well to treatment, showing early drop, the patient did not respond clinically and therapeutic abortion was done. However, as will be noted, the acetonuria was not controlled. Case No. 125862.

a normal sugar in the mild cases but an increased sugar in the severe cases. Titus found a low sugar and believes carbohydrate deficiency to be the chief underlying factor in pregnancy toxemia. However, a markedly perverted carbohydrate metabolism is well recognized (37) and glucose is generally given because it spares protein and fortifies the liver.

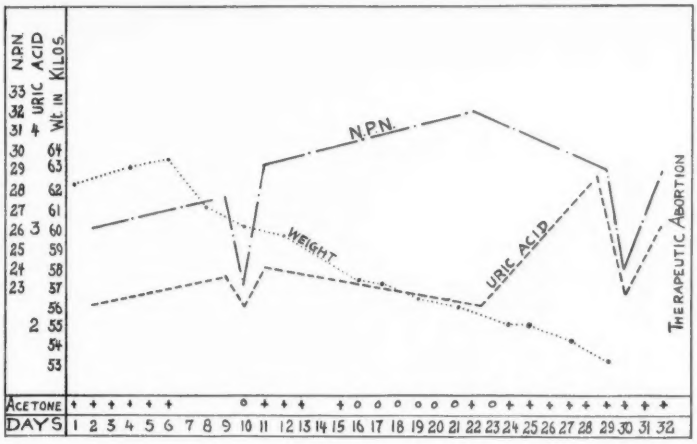
The carbon dioxide curves are very interesting and show wide fluctuations (Fig. 10). That the acid base equilibrium is not very stable in normal pregnancy is shown by MacNider who found that in normal pregnant animals there is a definite tendency for the acid base equilibrium of the blood to become disturbed and concludes, from a large series of experiments, that, associated with gestation, there is a definite tendency toward failure to maintain a normal acid base equilibrium. In normal pregnancy there is a reduced alkali reserve (42), as shown by lowered alveolar carbon dioxide tension (13) and a decreased carbon dioxide of the serum (18, 22, 32, 39). Oard and Peters revealed that this lowered alkali reserve was due to the decrease in the fixed base and not to an increase of acids. This was corroborated by Stander (42) who found the hydrogen-ion concentration within normal limits but due to the decreased serum bicarbonate there was a "compensated alkali or carbon dioxide deficit" rather than a true acidosis. Vozza showed that the decreased alkali reserve was more marked during the first stage of pregnancy and that 300 cubic centimeters of 10 per cent glucose or 10 units of insulin did not change it.

Peckham found a marked variation in the carbon dioxide combining power of the blood in vomiting of pregnancy. Our average carbon dioxide combining power was 46.3 volumes per cent and varied between limits of 27.7 and 64.5. The wide fluctuations may be due to the unstable acid base equilibrium and two opposing factors; one being the starvation acidosis and the other, due to loss of hydrochloric acid and electrolytes in the vomitus, producing an alkalosis. It has also been suggested that the rapidity of change may be of greater significance than the absolute level of the carbon dioxide combining power, as occurs with blood sugar changes in reference to hypoglycemic convulsions (20, 23). Frequent carbon dioxide determinations are, therefore, very necessary.

The serum proteins were not determined. Van Wyck considers them of prognostic significance. A high protein determination, with few exceptions, he thinks is a good prognostic sign. Low protein and dehydration signifies a long duration of symptoms with destruction of protein and serious prognosis.

The weight curve appears to be of definite value. Few clinics weigh the patients after admission to the hospital. Yet this is probably more important than the pulse rate in these patients. It is difficult to determine how much weight the patient has lost when she enters the hospital as the figure given by her is often unreliable unless she has been carefully observed. In this series it was given as from 10 to 30 pounds. Peckham reports 6 patients with a loss of weight over 30 pounds, but the loss of weight on admission apparently had no relation to the response to treatment.

Our patients are now weighed every day or on alternate days. The scale is wheeled to the bedside. If the patient is very ill, she can be


N.P.N.
URIC ACID
Wt. IN KILOS
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WEIGHT
URIC ACID
THERAPEUTIC ABORTION
ACETONE
DAYS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

Fig. 7. There is a gradual increase in non-protein nitrogen and uric acid. Note the absence of initial drop, and continued loss of weight. Therapeutic abortion was necessary. Case No. 93434.

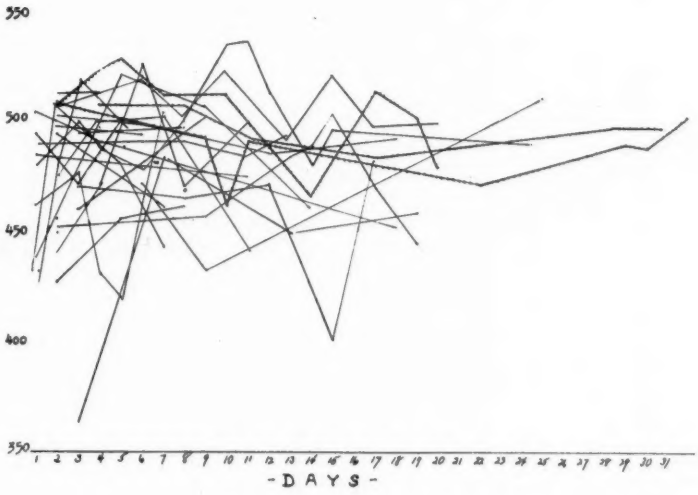

Fig. 8. Sodium chloride. The heavy dotted lines are curves of cases requiring therapeutic abortion.

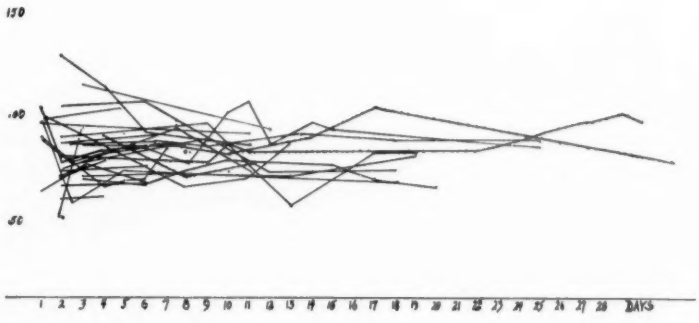

Fig. 9. Blood sugar.

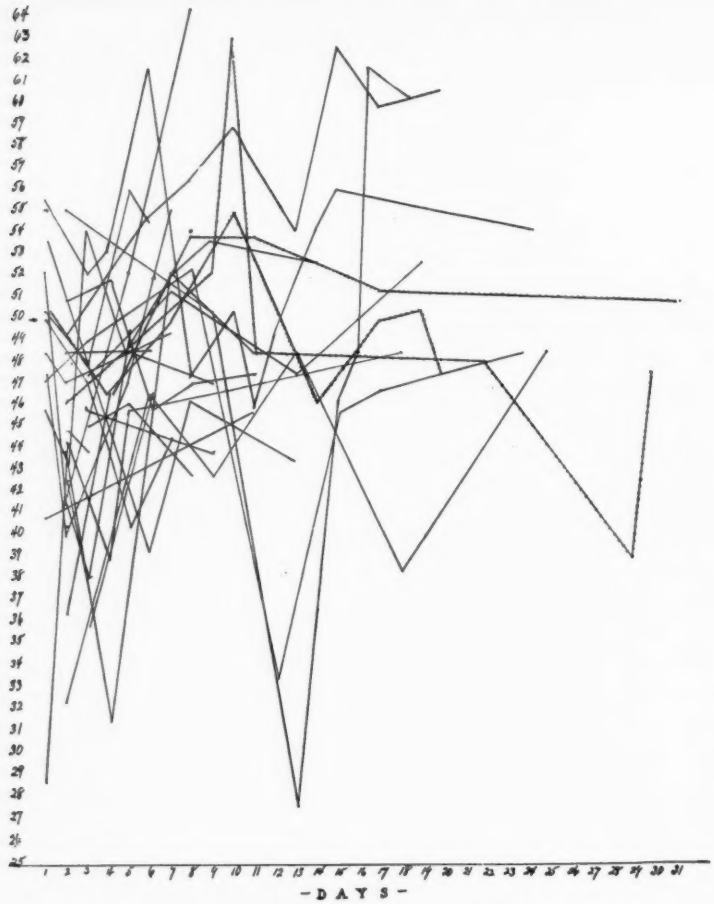

Fig. 10.—Carbon dioxide combining power.

lifted onto the stretcher scale and weighed with little or no disturbance. On admission the patient is already dehydrated, has lost considerable weight, and the subsequent loss is usually important. Figure 11 reveals the weight curves of 17 patients. The average curve generally has an initial rise due to the intravenous fluids administered. It then gradually subsides and with improvement of the patient it begins to rise. In 3 cases in which therapeutic abortion was necessary, the weight curve continued to drop (Figs. 6, 7, 11). One patient lost weight rapidly but as the acetonuria cleared up after hypodermoclysis, and as the blood chemical findings indicated that the patient was reacting favorably, we were not alarmed.

A conspicuous and almost constant finding on admission to the hospital is acetonuria (Table II). This was present in 40 cases and absent in 5 cases. In the latter cases the condition was comparatively mild and required no intravenous therapy. Two patients showed no acetone on admission but did show a trace shortly thereafter. These two patients were each given intravenous injections of glucose. Small amounts of glucose given to starving animals will cause the appearance of a great

TABLE II.—ACETONURIA

	Cases
In urine on admission	40
Not present on admission	5
Determination not done on patient	2
Determination not stated	1
Negative on admission but present after intravenous glucose	2
	50

number of acetone bodies in the urine (38). Ketosis as it affects the human organism, however, is not entirely the same as in other species; rats and other animals are very resistant to the development of ketosis (16).

A diet poor in carbohydrates leads to the excretion of acetone bodies in normal pregnant women whereas on an identical diet the non-pregnant women will show no acetone (29, 30). Schmidt and Wingen noted that the large carbohydrate requirement of pregnancy is met by conversion of fat to glycogen and that acid by-products are likely to appear. In hyperemesis, as in starvation, the protein is spared to the very last while the fat is being burned. The fat content of the blood increases and acetone bodies appear in the urine. The acid bodies of the blood are increased in the vomiting of pregnancy according to various observers. Runge and Juhl observed increased amino acids, Loeser reports increased lactic acid, and Bokelmann and Bock found an increase in "acetone bodies."

That the acetone in the urine is not the immediate cause of the vomiting has been clearly shown by Harding (10) who placed pregnant patients on a high fat diet, and found that acetone appeared in the urine, but that none of the patients developed vomiting. There is a close association, however. Thalhimer, Waters, and others observed that the vomiting ceased with the absence of ketonuria. This usually takes place but often the acetonuria persists for a few days after the vomiting has ceased or the vomiting persists with negative acetone findings. However, in the latter condition, the acetone usually reappears within a short time if the vomiting continues.

From a consideration of the facts stated, the value of blood chemistry in hyperemesis gravidarum is at once evident. An extremely low chloride, sugar, or carbon dioxide value can be readily corrected. Mistakes of commission, as exemplified by the following report, can be obviated. Titus relates a case, in which a patient with almost continuous vomiting, acidosis, and dehydration was admitted to the hospital. A blood specimen was taken before the intravenous injection of glucose and it revealed a blood sugar of 230.

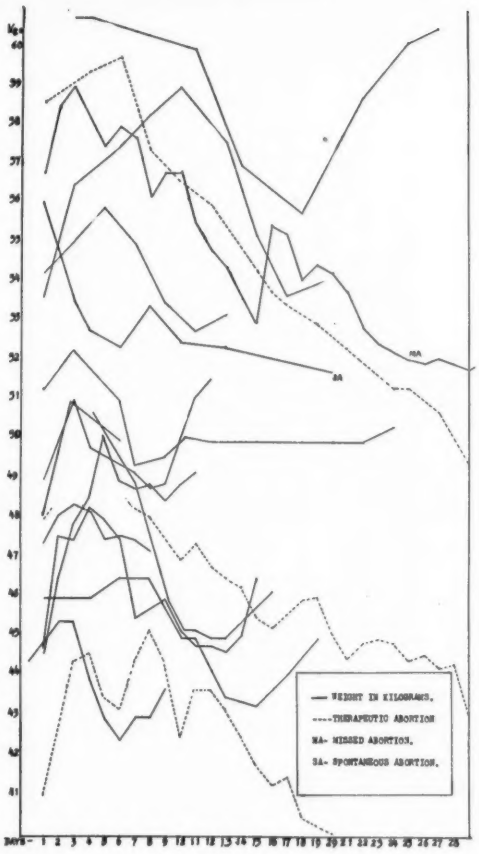

Fig. 11. Weight curves.

One cannot determine the prognosis by any one procedure or finding. It is necessary to take into account various factors. Often the prognosis is facilitated by observing the response to treatment. The objective factors in this study which are somewhat indicative of this response are the curves of the non-protein nitrogen and uric acid, the weight curve, and acetonuria.

It would seem that in the proper treatment of these patients, blood chemical studies are essential. The acidosis must be controlled and by the proper evaluation of the blood findings and weight curve, one can better arrive at a decision as to whether or not interruption of pregnancy is indicated. We consider retinal hemorrhages (40, 45) as absolute indications for interruption of pregnancy. The presence of jaundice is a further indication of the severity of the disease.

SUMMARY AND CONCLUSIONS

1. We classify all cases of hyperemesis gravidarum as toxemia.

2. The incidence in the woman's clinic of the New York Hospital is 0.71 per cent.

3. The average age in this series is 27.9 years and there is an increase in incidence in primiparæ but no apparent increase in elderly primiparæ.

4. Hyperemesis gravidarum is relatively infrequent in negroes.

5. The length of time in which vomiting persists, the duration of the pregnancy, the pulse rate, and the blood pressure have no definite relation to severity of the condition.

6. A high hemoglobin appears to be of some diagnostic significance and as a rule denotes marked dehydration.

7. The non-protein nitrogen content and the uric acid content may be increased but show a sharp drop after treatment with intravenous fluids. In some cases of late vomiting of pregnancy and in some patients who do not respond to treatment, the non-protein nitrogen content and the uric acid content tend to rise.

8. Blood chlorides and sugar values are usually within the normal limits. A few patients show extremely low values but respond to therapy.

9. There is a marked fluctuation in the carbon dioxide combining power of the blood with great tendency to acidosis.

10. Acetonuria is a conspicuous finding and although not the immediate cause of vomiting, control by proper therapy is important.

11. The value of blood chemical studies in the rational treatment of hyperemesis gravidarum is at once evident.

12. Prognosis is dependent upon the following: the hemoglobin values, the weight curve, the presence or absence of acetonuria, the blood chemistry determinations, and the effect treatment has on these factors.

13. Among the indications for interruption of pregnancy are continued loss of weight with rising non-protein nitrogen and uric acid, retinal hemorrhages, and marked jaundice.

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THE OBSTETRICAL SHOULDER TRAUMA

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THE term, "birth palsy" signifies all clinical manifestations which may be observed after trauma to the shoulder during delivery. The term is misleading. The sequelæ of shoulder trauma show that in the majority of cases the lesion does not involve the nerve trunks of the brachial plexus. The clinical material of the Istituto Rizzoli permits, according to Putti, the following classification of cases of "birth palsy."

Obstetrical trauma of shoulder joint	Simple: distortion
	Complicated: epiphyseal separation of upper end of humerus
	Fracture of clavicle
Obstetrical paralysis	Upper type
	Lower type
	Total type
	Associated atypical forms

There are also mixed forms with involvement of nerve roots and of the joint ends. These cases show the most complicated clinical picture.

This classification is of great practical value because, as stated by Putti, the clinical picture of the obstetrical trauma should not be confounded with obstetrical paralysis.

From 1899 to June, 1935, 199 cases of obstetrical shoulder lesions were observed in the Istituto Rizzoli; 71 cases were hospitalized, 128 were seen and given ambulatory treatment.

Statistically, it is demonstrable that the obstetrical shoulder lesions are more frequent in males (55.27 per cent) than in females (44.72 per cent), more often unilateral (93.46 per cent) than bilateral (6.53 per cent). The right side was involved in 62.81 per cent; the left in 30.65 per cent.

During delivery in the more common type of head presentation the right shoulder is pressed more often and longer against the pubic arch, which explains the more frequent involvement of the right side. In breech presentations, the obstetrical lesion is bilateral in the majority of cases (6 cases).

From The Istituto Ortopedico Rizzoli, Prof. Dr. Vittorio Putti, director.

In none of the cases was heredity a factor. Obstetrical shoulder lesions are acquired during delivery.

In the 199 cases, there were 62 cases of obstetrical joint lesions; 22 cases of obstetrical paralysis; 14 cases were mixed forms. (The 101 ambulatory cases could not be classified). This shows that joint lesions occur more frequently than the other forms and that the general opinion that obstetrical shoulder lesions are of nervous origin is not correct.

In this article, it is our purpose to discuss only the complicated obstetrical joint trauma, the lesion most frequently encountered in our series (53 cases). Although most of these cases came to clinical observation relatively late after injury, it was possible to determine that the primary lesion in all cases was an epiphyseal separation at the upper end of the humerus.

Our clinical and radiographic knowledge of epiphyseolysis in the newborn is not very extensive. Inasmuch as the clinical symptoms after epiphyseolysis are essentially the same as after obstetrical paralysis (functional disability and internal rotation contracture of the arm), these two essentially different lesions have been considered as the same. Poli has contributed valuable experimental, anatomical, and clinical data concerning the epiphyseal separation of the upper end of the humerus. We are here mainly interested in the roentgenological findings of the obstetrical shoulder trauma. On this basis, it will be possible to explain the after-effects of the complicated obstetrical shoulder trauma.

The x-ray picture taken in an early stage of the shoulder lesion is entirely negative: There are no changes in the upper end of the humerus. The first positive signs appear with the formation of periosteal callus in the form of a cloudy shadow around the upper end of the humerus (Fig. 1). Toward the third month, however, when the bony nucleus appears in the head of the humerus, a more precise statement can be made as to whether there was a

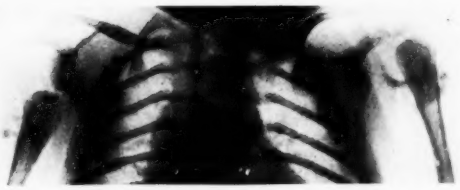

Fig. 1. Sixteen day old boy. Typical picture of bilateral periosteal epiphyseolysis with periosseous callus formation around metaphyses. Breech presentation, delivered by manual extraction.

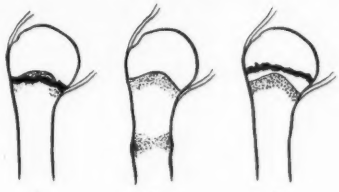

Fig. 2. A, Fracture through epiphyseal plate. B, Fracture line becomes displaced distally by the physiological bone growth. Roentgenograms show a line of condensation in the diaphysis. C, Fracture through epiphyseal cartilage. The fracture line is above the epiphyseal plate and there is no displacement by bone growth.

partial or complete epiphyseolysis with or without displacement of the upper end of the humerus (Fig. 2). Before the third month, some cases may show mild structural changes in the metaphysis, suggestive signs of traumatic lesion.

The exact diagnosis of a traumatic shoulder lesion is of great value. If there is no displacement of the epiphysis, almost complete cure can be expected without any involvement of the joint. If there is displacement, the clinical and roentgenological syndrome of obstetrical shoulder trauma will develop. Cases without displacement of the upper fragment show 4 to 5 months after birth some circumscribed enlargement of the diaphysis with periosteal callus undergoing resorption. These structural changes gradually disappear entirely and the shoulder joint remains intact. However, if there has been displacement of the cartilaginous epiphysis, the shoulder joint will show involvement. We believe that these cases do not represent a simple epiphyseolysis, i.e., a separation along the epiphyseal line, but a fracture through the cartilaginous epiphysis, which means that the separation is above the epiphyseal line. This assumption explains why so many cases are without periosteal callus formation during the first few weeks after delivery and why so rarely signs of hematoma or swelling of the shoulder are encountered.

SYMPTOMATOLOGY OF THE SEQUELÆ OF THE COMPLICATED SHOULDER TRAUMA (FIGS. 3–7)

On *inspection* (Figs. 3–7), one notices internal rotation of the upper arm and consequently pronation of the forearm. The arm is frequently kept slightly abducted with flexion in the elbow. If the abduction in the shoulder is not noticeable on inspection, it is due to the position of the scapula which is tilted with its greater diameter, the lower corner being approximated to the spine, the upper corner prominent under the upper margin of the trapezius muscle. On abduction of the arm, the symmetry of both shoulder blades can be restored.

This symptom is due to joint contracture, to shrinkage of the capsuloligamentous ap-

Fig. 3. Eight year old boy. Manual delivery with traction on left arm. Hypotrophy of deltoid muscle; abduction and internal rotation contracture of left shoulder, +. Loss of normal shoulder relief.

Fig. 3.

Fig. 4. Six year old girl. Manual delivery. On external rotation of left arm, the upper corner of the scapula appears below the margin of the trapezius. (Scapula sign of Putti.)

paratus. There are other signs of this contracture. Putti noticed that on external rotation of both arms, the upper corner of the scapula appears at the upper margin of the trapezius (scapular sign of Putti, Figs. 4, 6). This sign is due to joint rigidity by which all the arm motion is transmitted to the scapula. If the arm is abducted, the scapula rotates along its longitudinal axis and becomes elevated (Fig. 3).

If the arms are crossed in front by forced adduction, the scapula lies almost in a sagittal plane, the vertebral margin being sharply prominent under the skin (Fig. 5).

Fig. 5. Four year old boy. Forceps delivery. Atrophy of right shoulder muscles. Internal rotation of arm. Shortening of 1 centimeter. By adducting the arms (adduction on right side diminished) the vertebral margin of the scapula is brought almost into a sagittal plane.

The normal external configuration of the shoulder is lost. The arm hangs lower than its mate, the roundness of the shoulder relief has disappeared and sometimes the coracoid process is clearly visible under the skin. The loss of shoulder roundness is especially visible when the patient is looked at from above (Putti).

Fig. 6.

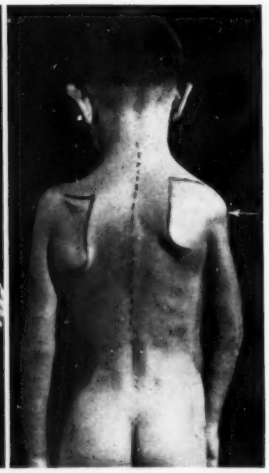

Fig. 7.

Fig. 6. Eight year old boy. Forceps delivery. No external rotation on right. Putti's scapula sign well visible. Loss of normal shoulder relief. Coracoid process strongly prominent.

Fig. 7. Same case as in Figure 6. Scapula high and hypoplastic. Abduction and internal rotation of right arm which is considerably shorter. Beginning left convex scoliosis.

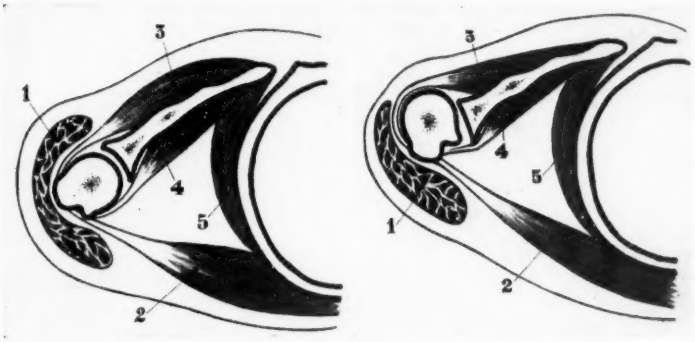

Fig. 8. Horizontal section through shoulder region (schematic) to illustrate the anatomic conditions of the different muscle groups in the sequelæ of obstetrical shoulder trauma. A, left. Normal conditions; B, obstetrical trauma. *1*, Deltoid muscle; *2*, pectoralis major; *3*, infraspinatus; *4*, subscapularis; *5*, serratus magnus. The obstetrical trauma with the resulting retroversion of epiphysis and the internal rotation of the arm leads to atrophy of the deltoid, *1*; pectoralis major, *2*; subscapularis, *4*, contracted because their points of origin and insertion are approximated. The infraspinatus muscle, *3*, is lengthened and under constant tension.

The shoulder muscles are fairly well preserved. They are hypotrophic, but there is not as much atrophy as is observed in nerve lesions. There is almost always present a shortening of the humerus (2 to 3 cm.), quite frequently there is also shortening of the forearm and hypoplasia of the hand. The scapula is always hypoplastic and its vertebral margin is at considerable distance from the thorax; the scapula is much higher, its inferior corner about 2 to 3 ribs higher than the normal side (Fig. 7).

On *palpation*, the head of the humerus is found smaller and displaced backward. It is not in front below the coracoid process but behind the acromial process in retroversion. It is impossible, even by passive motion, to center the head of the humerus into the glenoid fossa. Sometimes, however, on abduction and external rotation, it seems as though the head would slip into place with a little jump when the upper epiphysis passes over the posterior border of the glenoid. In almost all cases, from the third to fourth year of life, a definite step can be noticed in the posterior shoulder region, due to the inclination of the neck of the humerus, which is accentuated in these cases (Fig. 7).

Active motion shows: (1) abolition of external rotation, due to shrinkage of capsule and shortness of internal rotators; (2) limitation of abduction by about 50 per cent, partially compensated for by motion of the scapula; (3) limitation of flexion and extension. There is considerable joint rigidity which can also be noticed on passive motion (Fig. 8).

The *electric examination* does not reveal nerve lesions, nor muscle degeneration; quite frequently, however, the shoulder muscles are less responsive to faradic and galvanic currents, the result of inactivity. There is no disturbance of sensation.

Roentgen anatomy. The sequelæ of complicated obstetrical shoulder trauma have a typical x-ray appearance which permits early differentiation from pure obstetrical nerve lesions. The bony nucleus of the head of the humerus may appear later on the affected side. Typical cases show it displaced laterally over the outer half of the metaphysis; quite often it is slightly elevated from the inner side and it is always hypoplastic.

We tried to find out whether the lateral displacement of the epiphysis was only apparent and entirely due to the internal rotation. Figure 9 shows roentgenograms of a normal humerus in different projections. B is a view taken in moderate internal rotation. There is hardly any lateral displacement of the epiphysis. C is taken in forced internal rotation

A B C

Fig. 9. Normal left humerus of 3 year old boy. A, Roentgenogram in neutral rotation. B, In internal rotation. C, In total internal rotation. The epiphyseal bony nucleus does not rub any more over the inner half of the metaphysis, but is displaced laterally, overlapping the shadow of the greater tuberosity; the metaphysis has lost the normal roof shape and appears narrowed.

and reveals some lateral displacement. However, such a degree of internal rotation is never observed after obstetrical trauma and still the lateral displacement of the epiphysis is by far more marked in these cases. We deal therefore with a real displacement of the epiphysis which becomes more marked by internal rotation (Vannini).

If one takes roentgenograms of the shoulder joint in axial (craniocaudal) direction, one obtains pictures of great value (Fig. 10). Normal pictures reveal the epiphysis opposite the glenoid fossa and overlapped by the shadow of the acromion. In cases of obstetrical shoulder trauma, the epiphysis is always displaced clearly backward from the glenoid cavity and behind the shadow of the acromion. The glenoid is not always visible because the arm cannot be brought into full abduction.

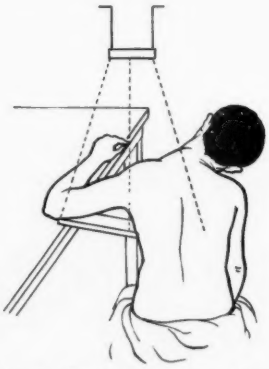

Fig. 10. Schema of axial projection of shoulder joint.

The axial view of the shoulder should be taken in every case of obstetrical shoulder trauma because it shows whether there exists a displacement of the epiphysis with increased angle of declination.

These roentgen findings are typical and can be observed up to about 3 years of age. When the bony nuclei of the tuberosities of the humerus begin to appear, their shadows overlap the epiphyseal nucleus, due to the inward rotation of the arm. The backward displacement of the epiphysis is less marked at the age from 8 to 10 and decreases even more as the years go by. However, it never disappears entirely. Simultaneously, the anteroposterior view reveals that the lateral displacement of the epiphysis becomes less, the bony nucleus—due to its hypoplasia and internal rotation—appears deformed, sometimes pear-shaped, sometimes triangular or boat-shaped.

We are unable to say how the epiphysis gets recentered; it is probably a progressive adaptation by growth and function.

There are also roentgenological signs of involvement of the other joint components. The hypoplasia of the epiphysis makes it appear as though there was a wide separation between epiphysis on one side and glenoid and acromion on the other. Quite frequently, the nuclei of both tuberosities appear later than on the other normal side.

The upper metaphysis of the humerus is smaller and flat instead of cone-shaped. An irregular condensation along the epiphyseal line is to be observed in the first year of life.

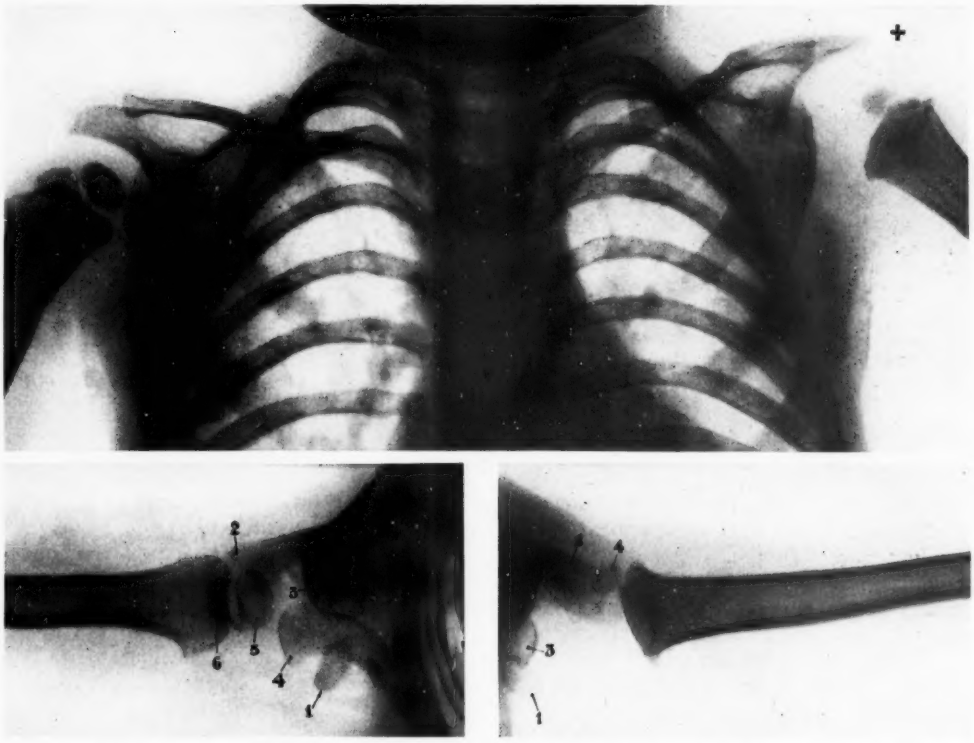

Fig. 11. Boy, 2½ years of age. Breech presentation. Manual extraction. Marked lateral displacement of the hypoplastic epiphysis. The bony nucleus of the greater tuberosity still absent (present on normal right side). Metaphysis narrowed, sclerotic, with loss of the normal roof-shape. Wide space between glenoid and epiphysis. Scapula high with atrophy of glenoid. Axial view: Right normal side. *1*, Coracoid; *2*, acromion; *3*, glenoid; *4*, acromial end of clavicle; *5*, epiphysis of humerus; *6*, greater tuberosity. The humeral epiphysis is below the acromion. Strong retroposition of epiphysis: *1*, coracoid; *2*, acromion; *3*, acromial end of clavicle; *4*, epiphysis of humerus.

Fig. 12. Four year old boy. Delivery by manual traction on right arm. Hypoplasia of epiphysis of humerus. Lateral displacement of bony nuclei of greater tuberosity and head of humerus. Scapuia high, hypoplastic, and anteverted. Axial view shows retroversion of epiphysis. *1*, Coracoid; *2*, acromion; *3*, epiphysis; *4*, greater tuberosity.

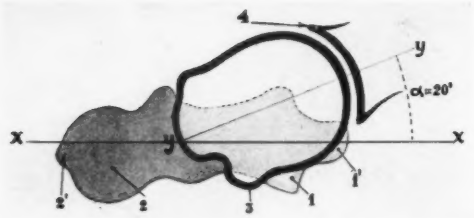

Fig. 13. Angle of declination of neck of humerus. Upper and lower end of humerus projected in horizontal plane. *1*, Trochlea humeri; *1'*, epitrochlea; *2*, capitulum humeri; *2'*, epicondylus lateralis; *3*, upper end of humerus; *4*, glenoid cavity; *y-y*, axis of head and neck; *x-x*, transverse axis of lower end of humerus. The angle between *x-x* and *y-y* is the angle of rotation or declination, *x*. It is about 20 degrees and opens inward and backward.

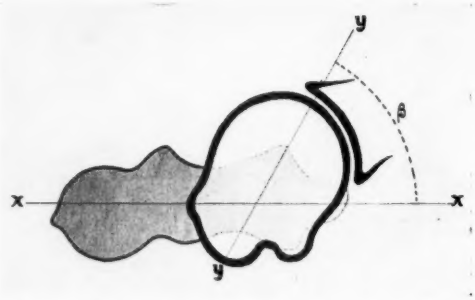

Fig. 14. Figures 14, 15, and 16 show the changes in the configuration of the humerus after obstetrical shoulder lesion. The angle of declination is increased by backward displacement of the axis *y-y*. The transverse axis of the lower end of the humerus, *x-x*, remains in the frontal plane. The contact surfaces between head and glenoid change.

This irregularity is hard to explain; most likely it indicates a traumatic lesion.

The glenoid, up to 3 or 4 years of age, does not differ appreciably in shape and development from the normal. Changes appear around the fourth year of life. First only a slight hypoplasia can be noticed which gradually increases to a real aplasia. This is especially true for the lower half which appears to be cut away. The joint margin is sometimes sclerotic. There is no neck of the scapula. Rather frequently in more severe, inveterate cases (15 to 16 years) the lateral margin of the scapula runs directly into the glenoid. The aplasia of the glenoid corresponds exactly to that of the acetabulum in cases of congenital dislocation of the hip joint.

All these signs are associated with a general hypoplasia of the scapula, only the coracoid process and acromion appear larger, which fact is due to the oblique view in which the roentgenogram is taken (inclination of the scapula).

The clavicle very often shows signs of a fracture in the middle third, with callus formation in the first months of life, later with

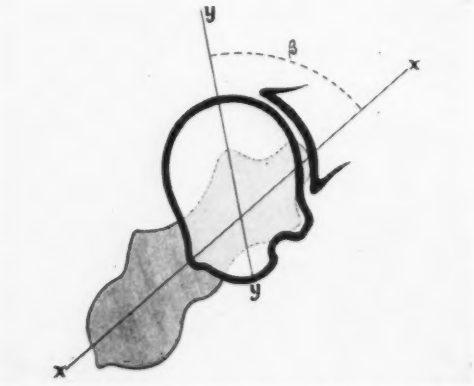

Fig. 15. If the increase of the angle of declination, *B*, is associated with an internal rotation of the transverse axis of the lower end of the humerus, *x-x*, the head has contact with the scapula only with its anterolateral pole. The epiphysis is turned backward and the greater tuberosity is in front. Such are the findings at surgical intervention.

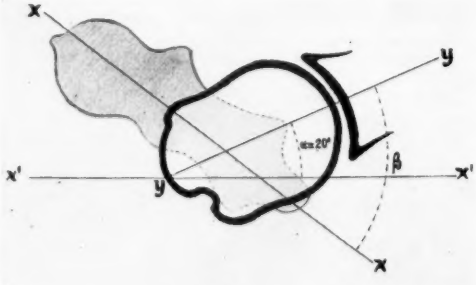

Fig. 16. The epiphysis of the humerus regains normal contact with the glenoid after the capsule has been cut and the extremity turned outward. The transverse axis of the lower end of the humerus, *x-x*, shows marked external rotation because there is no change in the angle of declination, *B*. To re-establish normal anatomic conditions, it is necessary to break the continuity of the humerus between epiphysis and diaphysis and to turn the lower fragment inward, thus decreasing the pathologic angle, *B*, to the normal angle, *x*.

irregular sclerosis in the middle third. It is hypoplastic, shorter and, in some cases, its S-curve is accentuated. Due to the elevation of the scapula it may appear turned forward.

SURGICAL ANATOMY

Muscles. The contraction of the subscapularis muscle (frequently also of a small part of the pectoralis major) commonly limits external rotation. It is almost always present in cases over 6 years of age, but may be absent in younger individuals. There may also be a shortening of the coracobrachialis and of the short head of the biceps which explains the slight flexion contracture of the elbow (Fig. 8).

Capsule. If there is no contracture of pectoralis and subscapularis muscles, the obstacle to external rotation is represented by the thickened, contracted joint capsule. Even after myotomy of the pectoralis and subscapularis muscles, external rotation is not complete. To obtain full external rotation, it is necessary to cut the joint capsule. The main reason for the internal rotation of the arm is the shrinkage of the anterior portion of the joint capsule. In the same way, the abduction contracture is principally due to contracture of the upper portion of the joint capsule and of the scapulohumeral ligament. There are also small adhesive bands at the joint margins in the upper and front parts of the shoulder joint.

Head of humerus. After incision of the joint capsule, one finds that the joint surface of the humerus is not in contact with the joint surface of the glenoid, neither with acromion and clavicle, but that it is displaced backward, retroverted and partially dislocated. In the typical position of internal rotation, the head of the humerus is in contact with the glenoid only with its anterolateral pole. If one brings the arm in external rotation and extension, a definite sound of reduction can be heard, and the head is brought into contact with the glenoid cavity and fills the subacromial space. On further forced external rotation, the head of the humerus slips out of the capsule, resulting in an infracoracoid dislocation of the shoulder and presenting itself for full inspection. The epiphysis is much smaller, deformed, either pear-shaped or gland-shaped. Some cases show circumscribed small areas of atrophy of the joint cartilage. The epiphysis is retroverted, displaced also medially along the metaphysis, and the angle of inclination is increased.

The *glenoid* shows the main changes in the lower half and along its anterior margin. It is hypoplastic, flattened, and, instead of being in a sagittal plane, it appears more in front. Its margin is frequently absent. Its visibility during surgical intervention is rather limited.

COMMENTS ON CAUSES OF DISPLACEMENT

From the findings on the operating table, we tried to reconstruct the anatomic conditions as they occur after the shoulder trauma. *The most constant and characteristic change is the deformation of the angle of declination.*[1] The angle of inclination is involved to a minor degree.

Figure 13 shows that the normal angle of declination is behind the transverse axis of the lower end of the humerus. If this is the case, the head of the humerus is in normal contact with the glenoid.

If the angle of declination increases by a backward displacement of head and neck of the humerus (the transverse axis of the lower end of the humerus remaining in the frontal plane), the contact surfaces between glenoid and head of humerus change (Fig. 14). If the declination increases by internal rotation of the transverse axis of the lower end of the humerus, those anatomical relations will be encountered as we found in our roentgenological and anatomical investigations: the head of the humerus will be brought in contact with the glenoid with its anterolateral pole. The epiphysis will be displaced backward, the greater tuberosity will be in front (Fig. 15).

After the joint capsule has been cut and the arm brought in external rotation, the epiphysis has normal contact with the glenoid, but the angle of declination remains unchanged and the axis of the lower end of the humerus will be rotated completely outward.

To re-establish normal anatomical conditions, which means to bring back in a frontal

[1] The angle of declination is formed by the axis of the upper end of the humerus in relation to the transverse axis of the lower epiphysis; it is about 20 degrees, open backward and inward. The angle of inclination is formed by the axis of the shaft of the humerus and the axis of head and neck. It is about 130°–140°.

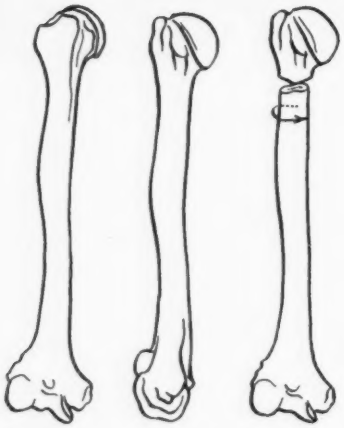

Fig. 17. Humerus after obstetrical shoulder trauma. A, Neutral rotation, epiphysis in retroposition. B, Complete external rotation, epiphysis is in normal contact with glenoid. C, Rotation osteotomy of Putti to bring the lower end of the humerus in a frontal plane.

plane the transverse axis of the lower end of the humerus while head and neck remain in normal position, it is necessary to interrupt the continuity of the humeral diaphysis (Putti) (Fig. 16). By this the inner rotators of the shoulder will be relaxed, the external rotators are put under tension (Fig. 8).

It is of interest to know whether at the time of the epiphyseolysis the epiphysis rotates externally (Kuestner) or internally, or whether the epiphysis remains in place and the diaphysis performs the internal rotation.

Our findings speak against Kuestner's hypothesis. If the epiphysis rotated outward and the diaphysis remained still, after consolidation internal rotation of the arm would bring the head of the humerus in full contact with the glenoid. If the epiphysis rotated outward and the diaphysis turned inward, further joint contracture in internal rotation would bring the epiphysis in a frontal plane. However, in all of our cases, the epiphysis was completely retroverted and only the anterolateral pole was in contact with the glenoid.

If the epiphysis remains still and the diaphysis turns inward, the olecranon would have to come in a frontal plane to give a retroversion of the epiphysis. This has never been observed, even in rather severe cases.

It is therefore more justified to assume that after the epiphyseolysis a primary displacement of the epiphysis takes place backward and inward. Only this assumption explains all the findings.

To explain how, after trauma, the characteristic internal rotation of the arm develops, one has to consider the distribution of agonistic and antagonistic muscle groups. Upon the upper fragment, in the sense of external rotation, act the infraspinatus, teres minor, and, in part, the supraspinatus muscles (the latter is mainly an abductor); in the sense of internal rotation only the subscapularis acts. No muscle can bring the lower fragment in external rotation, while internal rotation can be brought about by the action of the pectoralis major, latissimus dorsi, and teres major.

Thus, Kuestner's hypothesis, that the upper fragment turns outward, the diaphysis inward, would be based upon considerable muscle imbalance. Against it, however, speak clinical and roentgenological observations.

We believe that the *primary cause* of internal rotation is the defense position the injured arm assumes (in the newborn exactly in the same way as in the adult), which means the arm is rested against the chest for immobilization and prevention of pain.

This primary cause is followed by *secondary causes* which help to stabilize the deformity: contracture of internal rotators and of the capsuloligamentous apparatus. Also the pronation of the forearm (due to gravity) helps to augment the deformity as the years pass by.

One could think that the displacement of the epiphysis is gradually acquired during the persisting contracture in internal rotation. However, against this speaks: (1) the displacement of the bony epiphysis which is more marked in the first 2 to 3 years, and later on there is improvement instead of aggravation; (2) the absence of displacement in cases of pure obstetrical paralysis, even if, by muscle contracture the arm is kept in internal rotation.

DIAGNOSIS

The diagnosis of the obstetrical shoulder joint lesion is based upon (1) the typical symptomatology, characterized by rigidity of the shoulder joint; (2) the roentgenogram with

lateral displacement and retroversion of the epiphysis; (3) the complete absence of nerve lesions (electrical examination negative).

TREATMENT

During the first 2 years of life, the treatment is a conservative one for functional re-education. To prevent contracture in internal rotation, a shoulder spica cast is applied in abduction of 60 to 70 degrees and in maximal external rotation. The cast is changed after 1 month to increase external rotation. After two or three corrective casts, the joint and muscle contracture is usually overcome and a good degree of external rotation is obtained. A removable splint is then applied and physical therapy (heat, massage, exercises) started.

After the second year of life, the treatment must be surgical to correct the anatomical changes. According to Putti, the surgical treatment is characterized by two steps (1) myotomy and the capsulotomy of Sever, and (2) rotation-osteotomy of Putti (Fig. 17). The osteotomy is performed at a second operation in all cases in which retroversion of the epiphysis has taken place, while in milder cases, the procedure of Sever is sufficient.

SUMMARY

1. Obstetrical shoulder lesions can be classified in three groups: (a) obstetrical joint trauma, (b) obstetrical paralysis, (c) mixed form (paralysis plus trauma).

2. Electrodiagnosis and roentgenological examination permit differentiation between joint trauma, paralysis, and the mixed form.

3. Obstetrical joint trauma is most frequent lesion observed. It leads to epiphyseal separation at the upper end of the humerus with characteristic clinical and roentgenological manifestations, to an inward and backward displacement of the upper fragment with an increase of the angle of inclination and declination.

4. The treatment of the sequelæ of the obstetrical shoulder lesion is surgical. In cases with retroversion of the epiphysis two operations have to be performed: (1) the capsulotomy of Sever and (2) the rotation osteotomy of Putti.

THE BACTERIAL SPECIES FOUND IN NON-STERILE SURGICAL CATGUT SUTURES

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IN previous papers (1, 2, 3, 4) in which the results of my bacteriological researches of surgical catgut sutures were presented, I endeavored to emphasize the inefficiency and unreliability of the so called chemical sterilization of surgical catgut. I demonstrated that several brands of catgut sutures, tested by my bacteriological method (5), were non-sterile.

Bacteria in raw material. Bacteriological examinations of 20 specimens of sheep intestines from Spain, England, and Argentina revealed the presence of 13 different species of sporulating anaerobes of the pathogenic and non-pathogenic varieties; and these were designated by Piening as follows: (1) Fraenkel's gas bacillus (Bacillus welchii), (2) Bacillus novyi of malignant edema, (3) para-anthrax bacillus (Vibrion septique), (4) Bacillus histolyticus, (5) Bacillus putrificus verrucosus (Bacillus sporogenes), (6) Bacillus putrificus tenuis (Bacillus bifermentans), (7) Bacillus tertius, (8) Bacillus sphenoides, (9) Bacillus multifermentans, (10) Bacillus cochlearius, (11) Bacillus tetanomorphus, (12) Bacillus tetani, (13) Bacillus lichenoides. All these species, except the last one, are clostridium forms and, therefore, should have been so designated. The last species (Bacillus lichenoides) is not listed among the anaerobes in any standard work on systematic bacteriology; it may be the facultative anaerobe Clostridium licheniforme described by Weigmann.

In the United States, a study (8) of 83 specimens of raw catgut revealed the presence of pathogenic spore-forming anaerobes in 38 of the specimens examined. These comprised three species of gas gangrene organisms: Clostridium novyi, Clostridium septicum, and Clostridium welchii.

While these bacteriological investigations of the raw material are of scientific interest, the chief concern of the surgical and hospital professions lies in the possible presence of living bacteria in the finished product—surgical catgut sutures.

Gas gangrene infections. In 1923, and again in 1925, pathogenic sporulating anaerobes were isolated (9) from sutures taken from the same batch of catgut as that used for surgical patients in whom postoperative gas gangrene had developed with fatal issue. The infections occurred in two hospitals in New York City and involved two brands of catgut sutures. The sporulating anaerobes found in these sutures included Clostridium septicum, Clostridium sordelli, and Clostridium welchii.

Bacteria in catgut sutures. Regarding the kind of bacteria in contaminated catgut sutures, it has been stated (6): "While it is true that the majority of bacteria which contaminate catgut are non-pathogenic anaerobic bacilli, the presence of gas-forming anaerobic bacilli, or the relatively more serious tetanus bacilli, can never be excluded."

In spite of this statement, however, a search of the literature failed to disclose any reference to a systematic study of a large number of brands of catgut ever having been made for the purpose of determining the species of bacteria present in contaminated surgical catgut; and, therefore, there did not appear to be any reliable data on which the foregoing statement could be based.

MATERIALS AND METHODS

Because of the widespread interest which my investigations of the sterility of surgical catgut sutures aroused, it seemed desirable to identify the various species of bacteria present in non-sterile brands of catgut. Accordingly, during the years 1935, 1936, and 1937, I purchased periodically from various sources in the open market several lots of each kind and variety of catgut sutures (plain, chromic, tanned, Brady catgut, chloramine, copperized, iodized, formalized, pyoktanin, silver catgut, etc., including the boilable and non-

boilable varieties) which are manufactured in the United States, Austria, France, Germany, Great Britain, Holland, and Spain. The material comprised 14 brands of American made, and 22 brands of foreign made sutures. These brands, as well as all those examined during my previous investigations, were of current manufacture, and all of the firms were actively engaged in making and selling sutures when my purchases were made.

A total of 589 lots comprising 7,168 sutures was examined. Following the procedure adopted in all my previous catgut research, at least four sutures from each lot were first subjected to complete chemical analyses to determine the nature and amount of any chemical compound with which the sutures might be impregnated. Then, at least eight sutures of the same lot were tested in accordance with the bacteriological technique (5) previously outlined; except that the test organism now being used for controlling the growth-promoting properties of the culture medium is Clostridium lentoputrescens, since this is a slow-growing organism and most exacting in its anaerobic requirements.

The bacteria found in the non-sterile sutures were obtained in pure culture by the poured plate method; colonies were fished and the culture re-plated until pure culture was obtained. Anaerobic cultures were studied on freshly prepared cystein meat infusion agar plates. These plates were incubated at 37 degrees C. in jars in which anaerobiosis was provided by alternately exhausting with a vacuum pump and rinsing with pure carbon dioxide, after the method employed by Hartsell and Rettger. This process was repeated three times, and the jars sealed after the final exhaustion. Identification of the various bacteria was made in accordance with the procedures outlined in Bergey's *Manual of Determinative Bacteriology*, fourth edition, 1934; Ford's *Textbook of Bacteriology*, and Spray's "*Tentative Key*" (12). These comprised a study of (a) morphology; (b) spore formation and position; (c) cultural characteristics on solid and fluid media; (d) liquefaction of gelatin; (e) fermentation of various sugars; (f) production of indol; and (g) reduction of nitrates.

RESULTS

Of the 36 brands of catgut sutures examined, 15 brands, or 41 per cent, were found to be non-sterile. Of the 589 lots tested, 161 lots or 27 per cent contained non-sterile sutures.

From the non-sterile catgut sutures, 36 spore-forming bacterial species were isolated and identified; including 5 sporulating anaerobes (Clostridium bifermentans, Clostridium fallax, Clostridium histolyticum, Clostridium sporogenes, and Clostridium welchii), together with 31 aerobic and facultative spore-forming bacilli. Classification of this latter group into species presented a real problem, since the genus bacillus has been overburdened with inadequately described species. As a result, the allocation of strains to the proper species within this bacterial genus is difficult and often uncertain. From the work done, it seems that most of the strains are closely related and belong either to the species Bacillus mesentericus or to Bacillus megatherium. However, other strains very closely resembled Bacillus brevis, Bacillus cereus, Bacillus circulans, Bacillus cytaseus, Bacillus laterosporus, Bacillus mycoides, Bacillus polymyxa, Bacillus terminalis, and Bacillus vulgatus. None of the strains conformed to all the cultural characteristics of Bacillus subtilis, as described by Bergey, which accounts for the absence of this species.

All the aerobic and facultative spore-forming bacilli, together with two species (Clostridium bifermentans and Clostridium sporogenes) of the sporulating anaerobes, are commonly considered non-pathogenic; but the three other species of sporulating anaerobes (Clostridium fallax, Clostridium histolyticum, and Clostridium welchii) are pathogenic.

The principal habitat of these bacteria is the soil; but some of the species are also found in the intestinal canal of man and animals, and some occur in gas gangrene wounds.

Some sutures of some brands of catgut contained aerobic and facultative spore-forming bacilli which are non-pathogenic, while in other sutures of the same lot were found pathogenic, sporulating anaerobes.

Upon chemical analyses of sutures of those brands of catgut which proved to be non-sterile, appreciable quantities of soluble chem-

ical compounds were found; and the physical characteristics of these sutures indicated that they had been subjected either to a low degree of heat or no heat.

SUMMARY AND CONCLUSIONS

1. A comprehensive bacteriological study extending over a 3-year period was made of 36 brands of American and foreign made catgut sutures, of which 15 brands, or 41 per cent, were found to be non-sterile; and of the 589 lots tested, 161 lots, or 27 per cent, contained non-sterile sutures. This study, therefore, confirms my previous researches of catgut sterility (2, 3).

2. During this study, 36 spore-forming bacterial species were isolated and identified. These comprised 5 sporulating anaerobes, together with 31 aerobic and facultative spore-forming bacilli which grew usually under aerobic conditions but sometimes when cultured anaerobically.

3. A significant result of this investigation was that all the bacteria isolated from the non-sterile sutures are spore formers.

4. The presence of spore-forming bacteria in catgut sutures constitutes a potential danger to the patient for two reasons: first, as so ably pointed out by Small, bacterial spores may remain viable although inactive for a considerable period of time, during which bacterial activity may occur through tissue damage as a result of mechanical or chemical injury, concurrent infection, or even cold which inhibits phagocytosis; and, second, if the sterilizing process does not include heat of a sufficiently high degree and long enough duration to kill the non-pathogenic spore formers, it is quite obvious that it cannot be depended upon to destroy those pathogenic species (such as Clostridium tetani) which have a higher thermal death point and which may be present in other sutures of the same lot of catgut.

5. All except three species (Clostridium fallax, Clostridium histolyticum, and Clostridium welchii) of the bacteria found in non-sterile sutures during this investigation are commonly considered non-pathogenic. It should be borne in mind, however, that while some of the sutures of some brands of catgut contained aerobic and facultative spore-forming bacilli which are non-pathogenic, yet in other sutures of the same lot of catgut were found pathogenic, sporulating anaerobes.

6. Most of the aerobic and facultative spore-forming bacilli isolated during this study use a great deal of oxygen for their growth. If these bacteria are present in catgut sutures which are introduced into tissues, they may consume all the oxygen which is present, thus bringing about anaerobic conditions which, in turn, favor the growth of such anaerobes as Clostridium fallax, Clostridium histolyticum, Clostridium welchii and other gas gangrene organisms if they should also be present. Again, while it is probably true that Clostridium bifermentans and Clostridium sporogenes are commonly non-pathogenic when rabbits and guinea pigs are inoculated subcutaneously with pure cultures, nevertheless, when catgut sutures containing these sporulating anaerobes are buried in the tissues of surgical wounds, these organisms possibly may prove to be pathogenic.

7. Chemical analyses of sutures of those brands of catgut which were found to be non-sterile revealed appreciable amounts of soluble chemical compounds. Moreover, their physical characteristics indicated that they had been exposed to a low degree of heat or even none at all. Therefore, in the preparation of these non-sterile sutures, entirely inadequate heat or none whatever was used for sterilization purposes; reliance having been placed apparently upon chemical methods. On the other hand, sutures of those brands of catgut which were found to be absolutely sterile showed every evidence of having been subjected to high heat sterilization. As emphasized in a former paper (1):

"1. The so called chemical sterilization of surgical catgut by any method yet devised is inefficient and unreliable.

"2. Carefully controlled heat sterilization is the only uniformly reliable and positive method of sterilizing surgical catgut sutures."

It is a pleasure to acknowledge my gratitude to Mr. J. Roger Porter, Laboratory of Bacteriology, Yale University, for his advice and valuable assistance in classifying the aerobic and facultative spore-forming bacilli isolated during this investigation; and to Professor Robb Spalding Spray, Department of Bacteriology and Public Hygiene,

West Virginia University School of Medicine, for his assistance in clarifying the nomenclature of the sporulating anaerobes and for his valuable suggestions. Also, to Dr. Stanhope Bayne-Jones, Dean and Professor of Bacteriology, Yale University School of Medicine, and to Professor C.-E. A. Winslow, Department of Public Health, Yale University School of Medicine, for their helpful suggestions.

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ENDOCHOLEDOCHAL SPHINCTEROTOMY

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PHYSIOLOGICAL disturbances of the sphincter of Oddi bear an important relationship to certain types of acute pancreatitis, gall bladder disease, the post cholecystectomy syndrome, the dyskinesias of the biliary tract and some forms of transient jaundice. Spasm of the sphincter which is a basic factor in the production of these pathological states, has recently been demonstrated by roentgenologic x-ray studies of lipiodol injections of the choledochus (2, 7), together with pharmacological studies of the intraductal pressure recorded kymographically, according to the method described by Katz.

It is extremely important, therefore, in order properly to treat many of the aforementioned conditions, that spasm of the sphincter of Oddi be relieved either temporarily or permanently. It is well known that some of the patients with sphincteric spasm respond readily to medical therapy, especially those cases which presumably have their origin in either endocrine disturbances or imbalances of the sympathetic nervous system. Other patients have been definitely benefited by rest, dietetic measures, and duodenal lavage. But quite often these conservative measures fail, and the persistence of severe and distressing symptoms make surgical intervention imperative. It is in those cases especially, when careful surgical exploration fails to disclose any gross pathological alterations, that attention should be focused upon a dyskinesia of the sphincter of Oddi as the possible cause of the symptomatology.

There are several surgical procedures which may be employed to relieve this localized muscular spasm.

Forceful dilatation of the sphincter obtained by the passage of graduated sounds through the common duct into the duodenum will undoubtedly paralyze the musculature for a long time. This simple method advocated by many appears rather crude and traumatic. It has been complicated by an ascending anaerobic infection from the duodenum and deaths from Welch infections due to Bacillus welchii, have been reported.

Biliary duodenal intubation accomplishes practically the same result as instrumental dilatation. The indwelling tube insures not only a free internal drainage of bile, but by its mechanical presence maintains a persistent dilatation of the sphincter until the spontaneous elimination of the tube. This method advocated by Duval and Walzel, aside from certain technical difficulties, does not seem particularly dangerous, especially if a tube of large caliber is used and sufficient of its length protrudes into the intestine. The method, however, has never gained great popularity.

There is another procedure which is advocated. Many European surgeons when confronted with dilatation of the choledochus associated either with impacted calculi, or sphincter spasm, or papillary stenosis, prefer an anastomosis between the common duct and the duodenum, eliminating entirely the sphincter mechanism and shortcircuiting the flow of bile. The operation of choledochoduodenostomy is attended by certain dangers. One of the most important of these, theoretically at least, is an ascending infection from a duodenal reflux. In spite of the fact that gastrointestinal x-ray studies in these cases often reveal the presence of barium in the common bile, the clinical incidence of ascending infection is quite rare. This has been verified by the reports of Sasse, Floercken, and Peterman, who have used choledochoduodenostomy in a large series of cases.

All of these surgical procedures, however, have certain definite disadvantages. Dilatation of sphincter and biliary duodenal intubation are only temporary measures because eventually the sphincter will regain its tone and periodic muscular spasms may recur. Choledochoduodenostomy as a cure for simple sphincter spasm presents rather a difficult

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technical problem. However, the sphincter of Oddi may be attacked directly. Its musculature may be permanently paralyzed by actual surgical division of its fibers. Transduodenal sphincterotomy may be a comparatively new term in operative nomenclature, but it is not a new procedure because transduodenal choledochotomy for impacted papillary calculi has been done for years and in this operation, division of the sphincter is essential in order to extract the stone. Recently Archibald has reported several cases in which the sphincter was divided for spasm, and del Valle has sectioned it transduodenally for "odditis." This latter condition manifests itself pathologically by the presence of a retracted sphincter which partially obstructs the free flow of bile.

Transduodenal papillotomy is not without risk aside from the immediate postoperative dangers of peritonitis and duodenal fistula because subsequent duodenal deformities due to adhesions may also result in physiological disturbances. Besides the eventual efficacy of transduodenal sphincterotomy for sphincteric spasm can only be evaluated after more information is gained by a careful follow-up of these patients. There are still many questions to be answered. Does division of the sphincter permanently destroy its action?

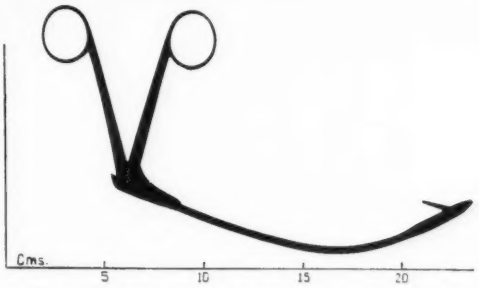

Fig. 1. The sphincterotome with knife blade open. The shaft, which is 16 centimeters long and 4 millimeters in diameter, has a flattened tip measuring 35 by 6 by 2.5 millimeters. The shearing blade which fits into a slot in the tip, has a thickness of 1.5 millimeters and an effective cutting length of 11 millimeters.

Does the scar resulting from this section cause a secondary contraction of the papilla, and does this result in a stenosis with biliary stasis?

Certain of the obvious objections to transduodenal sphincterotomy may be eliminated by endocholedochal sphincterotomy. Recently the results of dividing the sphincter through the common bile duct by means of a sphincterotome (Fig. 1) in cholecystectomized dogs were published (2). The operation which was perfectly feasible, effected a definite reduction in the function of the sphincter mechanism and was not followed by any evidence of ascending infection of the biliary tract. This procedure was then tried on a series of cadavers. Its safety was demonstrated as far as

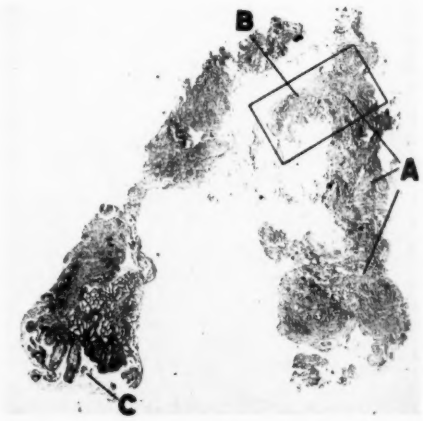

Fig. 2. Photomicrograph of a portion of the tissue punched out by the sphincterotome. Note *A*, the smooth muscle fibers of the sphincter of Oddi, *B*, the mucosa and the glands of the wall of the choledochus, and *C*, the mucosa of the duodenum. ×27.

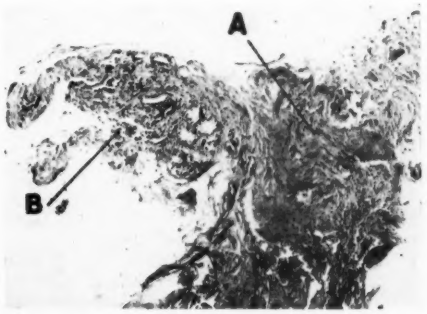

Fig. 3. Part of Figure 2. This photomicrograph has been given a greater magnification to show clearly *A*, smooth muscle fibers, as well as *B*, the folds and glandular structure of the mucosa of the terminal portion of the choledochus. ×135.

Figs. 4, left, and 5. Lipiodol study 11 days after sphincterotomy. The resistance of the common duct sphincter was so low (Fig. 4) that the terminal portions of the hepatic ducts and the upper end of the choledochus were not outlined before lipiodol entered the duodenum. Following the administration of morphine (Fig. 5) the duodenal wall was clearly seen to become spastic, compressing the intramural portion of the choledochus. The resultant increase in the resistance was slight, since only the terminal portion of the hepatic ducts was visualized before lipiodol entered the duodenum. These studies confirm the results of the kymographic tracings (Figs. 8, 9, 10).

visible injury to the duodenum and pancreas was concerned. The method was recently tried clinically.

The following case, presumably one in which the clinical picture was due to periodic episodes of sphincter spasm is of interest because the attacks apparently were relieved by endocholedochal sphincterotomy.

L. C., a married female, 24 years of age, was referred to me by Dr. I. A. Feder of Brooklyn, New York, to whom we are indebted for her history and laboratory studies. She was first admitted to the Beth El Hospital, Brooklyn, New York, on August 5, 1932, and discharged during November, 1932. Her past history was practically negative except that for 2½ years following her second pregnancy, she had experienced attacks of right upper quadrant pain which radiated to the back and right shoulder.

The present illness began rather abruptly with high fever, chills, delirium, and rigidity of the neck. The physical examination revealed findings suggestive of typhoid fever, which all laboratory data confirmed. During the fourth week of her illness, the temperature instead of subsiding, continued in an intermittent fashion. The patient complained of severe pain in the right upper quadrant of the abdomen, and on physical examination a mass was noted in this region. There was no jaundice and the white blood count was normal. In spite of the fact that the patient was critically ill, a laparotomy was performed under spinal anesthesia, on September 14, 1932.

An enormously distended, partially necrotic gall bladder with a pericholecystic abscess completely enveloped by omentum, was found. There was a stone in the cystic duct. A cholecystostomy was made and a cigarette drain was inserted to Morrison's pouch. Cultures of pus from the gall bladder were positive for Bacillus typhosus and Staphylococcus albus. The postoperative course was rather stormy, and although at one time there were clinical signs of subphrenic abscess, the condition subsided spontaneously. The patient was finally discharged with a biliary fistula, which eventually closed in 2 months' time.

The patient then began to experience attacks of severe biliary colic which were relieved only when the fistula spontaneously reopened with the free discharge of bile and pus. Because of these repeated episodes, the patient was admitted to the Brooklyn Jewish Hospital for exploration, May 30, 1933. The operation which was performed under spinal anesthesia, revealed a chronically inflamed gall bladder with stones in the cystic duct. The common duct was probed and found free. Following a cholecyst-

Figs. 6, left, and 7. Lipiodol studies before (Fig. 6) and after (Fig. 7) the administration of morphine in a patient whose kymographic studies are recorded in Figure 3. Note that both in Figure 4 (manometric resistance 165 millimeters) and in Figure 6 (manometric resistance 160 millimeters), the terminal ends of the hepatic ducts are visualized to an equal extent. The spasm produced by morphine in the intact sphincter of Oddi (Fig. 7) raised the resistance to such a height (370 millimeters) that the very fine biliary radicles were visualized before lipiodol entered the duodenum.

ectomy, she made an uneventful recovery and was discharged June 18, 1933.

She remained well but for a short time when she began to experience episodes of pain which were described as rather characteristic. A few days previous to the onset of the attack, the patient experienced severe hunger. The pain then started in the right lower quadrant, radiating around the right side to the back, and upward to the right shoulder and arm. There was nausea but no vomiting. The pain lasted for a short time and either terminated spontaneously or was relieved by an injection of morphine sulphate, at times ¾ of a grain being required (nitroglycerine was without effect.) After the attack subsided, there was residual tenderness in the right upper quadrant and along the course of the colon, and pruritus which was followed by a generalized urticaria. Jaundice was never noticed.

During the past year, the patient also complained of menstrual disturbances in that her periods occurred irregularly every 2 or 3 weeks. The bleeding occasionally was slight and lasted a few days, and at other times it was more profuse, and persisted from 10 to 12 days. It was noted too, that her weight increased from an average of 150 to about 175 pounds.

Because of the patient's unusual sequence of symptoms, it was decided to hospitalize her for a period of observation. She was readmitted to the Beth El Hospital on February 15, 1937. The following laboratory reports were of significant value:

Blood chemistry, February 17, 1937, showed: serum albumin, 4.3 milligrams per cent; serum globulin, 2.4 milligrams per cent; total serum protein, 6.7 per cent; glucose, 0.86 milligrams per cent; urea, 11.5 milligrams per cent; creatinine, 1.2 milligrams per cent; cholesterol, 110 milligrams per cent; cholesterol ester, 54 milligrams per cent.

Galactose tolerance test, February 19, 1937, showed: blood sugar—fasting, 0.87 milligrams per cent; ½ hour, 0.95 milligrams per cent; 1 hour, 0.93 milligrams per cent; 1½ hours, 0.94 milligrams per cent; 2 hours, 0.40 milligrams per cent; urinary sugar negative in all 5 specimens.

Glucose tolerance test, February 29, 1937, showed: blood sugar—fasting, 0.72 milligrams per cent; ½ hour, 0.95 milligrams per cent; 1 hour, 0.96 milligrams per cent; 1½ hour, 0.93 milligrams per cent; 2 hours, 0.90 milligrams per cent; urinary sugar negative in all 5 specimens.

Bile drainage—A and C bile was obtained, but no B bile. Microscopic examination showed no cholesterol crystals or other abnormal constituents.

Gastric analysis with alcohol test meal showed:

	Free hydrochloric acid	Total acidity
Fasting	1	16
½ hour	58	76
1 hour	26	40

Blood count showed, 12,800 white cells: polymorphonuclears, 63 per cent; lymphocytes, 37 per cent.

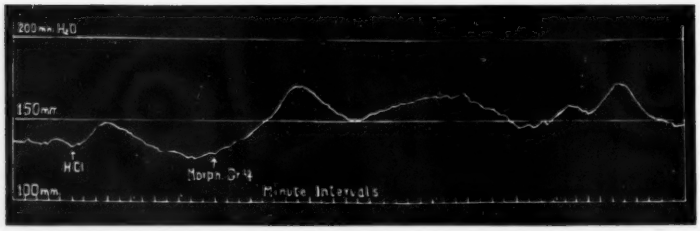

Fig. 8. Kymographic record of the resistance of the sphincter of Oddi 10 days after endocholedochal sphincterotomy. The resistance was found to measure 130 millimeters of water. Following intraduodenal instillation of dilute hydrochloric acid, the resistance rose to 145 millimeters, falling to the original level in 10 minutes. The hypodermic injection of morphine caused the resistance to rise to 145 millimeters at which level it remained for the duration of the experiment.

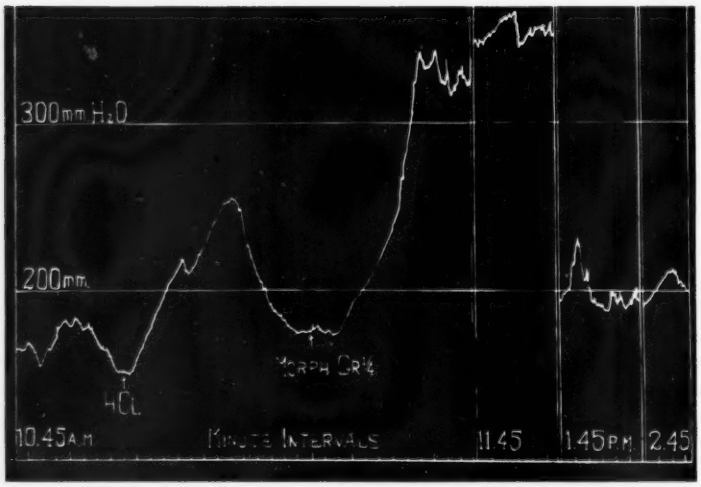

Fig. 9. Typical kymographic tracing in a patient in whom the sphincter had been left intact. The original resistance (160 millimeters of water) rose to 255 millimeters following the local application of dilute hydrochloric acid. The spasm produced by morphine raised the resistance to 370 millimeters of water.

Wassermann and complement fixation tests were negative. Basal metabolic rate was −22. Roentgenogram of the sella turcica was negative. Examination of the right upper quadrant by flat x-ray plate showed a peculiar linear shadow density about ¾ inch long. Its cause could not be made out.

After her discharge from the Beth El Hospital February 26, 1937, she was given thyroid and pituitary gland extracts without relief. In view of the repeated attacks of pain, exploratory laparotomy was advised since it was felt that the patient was suffering either from periodic attacks of spasm of the sphincter of Oddi or possibly a common duct stone.

The patient entered the Mount Sinai Hospital on March 25, 1937, and was discharged April 11, 1937.

An exploratory operation was done under avertin, supplemented by gas, oxygen and ether anesthesia on March 26, 1937. The liver and gall bladder bed appeared normal. There was no evidence of a cystic duct. The common bile duct, which was normal throughout its course, did not appear dilated, and on aspiration was found to contain clear, golden yellow bile. The stomach, duodenum, and pancreas which were clearly visualized, were normal. The uterus was retroverted, but normal in size and shape. The adnexa felt normal. There were many intraperitoneal adhesions which were divided in order to expose the common bile duct adequately. By means of the Hoffman punch a biopsy specimen was taken from the liver and pancreas. (These were subse-

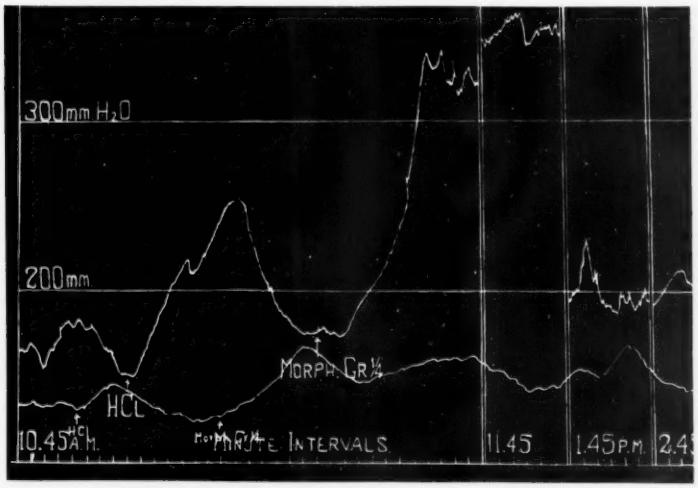

Fig. 10. The tracing from the patient in whom the sphincter of Oddi was sectioned (Fig. 2) superimposed upon the tracing in a patient with an intact sphincter (Fig. 3). The difference in the levels of the tracings clearly shows the small part played by the duodenal musculature and the important part played by the sphincter of Oddi, especially after the local effect of hydrochloric acid and the effect of morphine.

quently reported as showing no significant changes.) The common bile duct was incised between Allis clamps and, probed without difficulty, and did not contain any calculi. The sphincterotome (Fig. 1) was introduced into the common bile duct and through the sphincter into the duodenum. The knife was opened and the instrument withdrawn until it firmly infringed upon the sphincter. The knife was closed, thus dividing the sphincter without difficulty. The instrument was withdrawn, and the piece of tissue which had been punched out was removed from beneath the blade and sent to the pathological laboratory for study (Figs. 2 and 3). A T tube was inserted into the common bile duct and sutured about the tube with four interrupted chromic sutures. Two rubber dam drains were placed to the region of the common duct, one above, and one below the tube. The abdomen was closed in layers using chromic throughout, with silk and pincettes for the skin.

Postoperative course. There was an immediate postoperative rise of temperature to 103 degrees. This gradually fell to normal on the fifth day. There was free drainage of bile through the choledochostomy tube on the second day, at which time the return from an enema revealed a normal stool containing abundant bile. Lipiodol studies (Figs. 4, 5, 6, 7) and manometric studies after the method of Katz (Figs. 8, 9, and 10) which are herewith recorded, were then made on the tenth and eleventh days after operation. The T tube which was removed on the twelfth day was not followed by any further discharge of bile. The patient was discharged on the sixteenth day.

The patient has been seen repeatedly, the last examination taking place on February 23, 1938. She had been perfectly well and has had no recurrence of her previous attacks.

It seems fair to assume that the attacks resembling biliary colic described by the patient, were presumably due to spasm of the sphincter of Oddi. This conclusion is further verified by the operative findings and the fact that following endocholedochal sphincterotomy, the attacks ceased. The cause of the spasm is open to question. The period of hunger preceding the episodes of pain, the increased tolerance to sugar as noted in the glucose and galactose tolerance tests (the latter almost a typical course of a true hypoglocemia), the menstrual disturbances, the gain in weight, and a low basal metabolic rate, point to an endocrine disturbance as the most likely etiological factor in the production of the muscular irritability. Conservative therapy, i.e., treatment by the administration of glandular extracts, was without effect. There is no doubt that the sphincter was divided endocholedocally because the specimen removed by the sphincterotome revealed biliary and duodenal mucous membrane and some

muscle (Figs. 2 and 3), and the x-ray findings following lipiodol injection and the kymographic tracing bear witness to its division. In spite of the fact that the sphincter had been divided, the duodenal musculature and the obliquity of the entrance of the common bile duct through its wall acted as an efficient protecting valve against the reflux of duodenal contents (Fig. 5). Clinically, the patient has remained in good health and has been free of attacks of colic following the division of the sphincter of Oddi.

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CLINICAL SURGERY

HALLUX VALGUS

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THE perplexing and intriguing problem of "bunions" has been attacked from many interesting and diverse angles by both foreign and American investigators. Despite the many excellent contributions in the literature, many necessary anatomical and physiological details, however, seem not always to have been sufficiently considered. This is especially true in the rôle of the sesamoids.

The writer having reviewed a number of cases operated upon at various clinics, undertook an independent investigation of the subject. Etiological, anatomical, physiological, pathological, pathophysiological, radiographic, and clinical data were considered in the light of a predominantly physiological rather than a plastic surgical repair.

An operative procedure which seems best to meet the surgical indications was evolved.

ETIOLOGY

In walking, as described by Hiss, the weight of the body converges from the "cuboid" (weight bearing) stream to join the "scaphoid" (walking) stream, and the combined load is finally distributed along the under surface of the great toe. Any factors, extrinsic or intrinsic, tending to shift this load more medially on the big toe, favor the development of hallux valgus.

Extrinsic factors include high heeled, pointed, short or poorly fitted shoes, and short or toe-constricting hose.

Among the more common intrinsic factors are torsional deformities involving the thigh, leg or foot, faulty foot posture, flat foot, adducted supinated forefoot, excessively high arch with compensatory forefoot pronation; overaction, spasm, or contracture of the adductor hallucis muscle; imbalance between peroneus longus and tibialis anticus muscles; excessive varus or short first metatarsal bone; congenital or acquired defects, or excessive rounding of the head of the first metatarsal; hyperextensibility at the metatarso-internal cuneiform or internal cuneiform-scaphoid joints, and accessory scaphoids.

From the Hospital for Joint Diseases, service of Harry Finkelstein, M.D.

The deformity primarily is merely a functional postural adaptation; later it becomes structural in character.

ANATOMY

Sesamoid bones. These play a most important rôle not only in the development but also in the surgical correction of hallux valgus. It is essential to bear in mind that: (1) These bones are intracapsular. They articulate by means of convex facets on their superior surfaces, with corresponding longitudinal grooves on the inferior aspect of the first metatarsal head. (2) They are contained in the double tendon of the flexor brevis muscle which inserts (via conjoined tendons) into opposite aspects of the base of the proximal phalanx (Fig. 1). Thus they move in whatever direction the great toe moves. This partly accounts for their displacement in hallux valgus. (3) Held together by the glenoid ligament, they move as one bone. (4) Together they form a movable groove for the protection of the flexor longus hallucis tendon. They are situated more posteriorly when standing, and anteriorly when the toe is dorsiflexed, as in walking. (5) The outer margin of the lateral sesamoid affords attachment for the powerful adductor obliquus tendon just before it merges into the formation of the conjoined tendon (Fig. 1).

First metatarsal bone. 1. There is a normal varus of this bone of between 8 and 12 degrees, due to the obliquity of its articulation with the internal cuneiform bone. This adds strength to the longitudinal arch. This articulation, in addition, permits of about 10 to 15 degrees of lateral, and a lesser degree of vertical, mobility, thus adding flexibility to the arch.

2. When the forefoot is supinated, varus of the metatarsals is relatively increased. On pronation, it diminishes. This affects the inner four metatarsals (Fig. 2). Normally, voluntary adduction of the forefoot is combined with inversion (supination); abduction, with eversion (pronation). The resistance of the ground in walking, as referred to by Steindler, may induce secondary compensatory detorsional changes in the position of the forefoot. Thus, in flat foot the forefoot eventually becomes supinated. The converse is true in high arch.

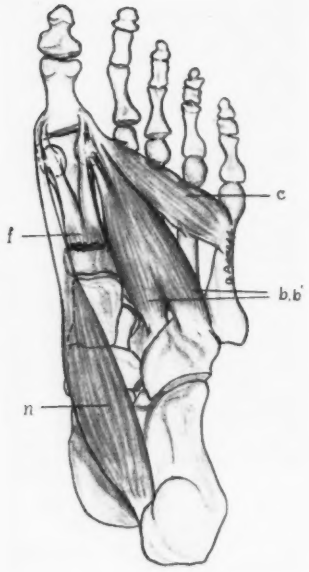


Fig. 1. Normal arrangement of abductor and adductor muscle groups of great toe. *f*, Flexor brevis muscle, two heads; *n*, adductor hallucis; *b*, *b'*, adductor obliquus, two heads; *c*, adductor transversus.

3. The articular cartilage covering the first metatarsal head continues for about 1/8 inch over its lateral surfaces. This cartilage forms a gliding mechanism for the obliquely placed collateral ligaments.

4. The tibialis anticus and peroneus longus tendons insert into opposite aspects of the base of this metatarsal. These maintain its physiological balance.

PHYSIOLOGY

As emphasized by McBride, the great toe is maintained in normal, forward alinement by the physiological opposing action of the abductor and adductor muscle groups. These insert by means of conjoined tendons into opposite aspects of the base of the proximal phalanx (Fig. 1). The abductor group comprises the medial head of the flexor brevis and the abductor hallucis muscles. The adductor group consists of the lateral head of the flexor brevis, the adductors, obliquus and transversus.

This opposing action is possible only so long as the abductor tendon retains normal position in its groove on the inferomedial aspect of the metatarsal head (Fig. 3a). (This tendon is here blended with the capsule.)

Fig. 2. Left, High arch with compensatory forefoot pronation. Right, Same foot in inversion (supination). Note change in direction of four inner metatarsals.

Pathological physiology. In the development of hallux valgus, as a result of the pathophysiological forces, the abductor tendon migrates. It moves from its groove on the inferomedial aspect of the first metatarsal head plantarward beneath the inferior margin of the head, then lateralward. It lodges in the groove for the medial sesamoid. Here it becomes firmly wedged, resulting in a fixed eversion of the great toe (Figs. 3b and 4). The sesamoid bones are thus crowded laterally. The medial one goes into the groove for the lateral sesamoid, and the lateral one into the interspace between the first and second metatarsal heads (Figs. 3b, 4, 5). This lateral subluxation is augmented by pull of the obliquus tendon via its lateral sesamoid attachment (Fig. 4).

In its displaced position, the opposing action of the abductor (to the adductors) is lost. It now acts as a flexor and evertor of the great toe. The unopposed adductors, aided by the "bowstring" (long, short flexor and extensor tendons), all tend to increase the hallux valgus deformity.

The medial portion of the capsule, the internal lateral ligament, and the slightly squared lateral margin of the metatarsal head, offer resistance to these deforming forces. In most instances, however, this is inadequate and soon overcome. During this interval, the apparent paradoxical condition of pronounced metatarsus varus with eversion of the toe and displacement of the sesamoids, without a corresponding hallux valgus deformity, may be found.

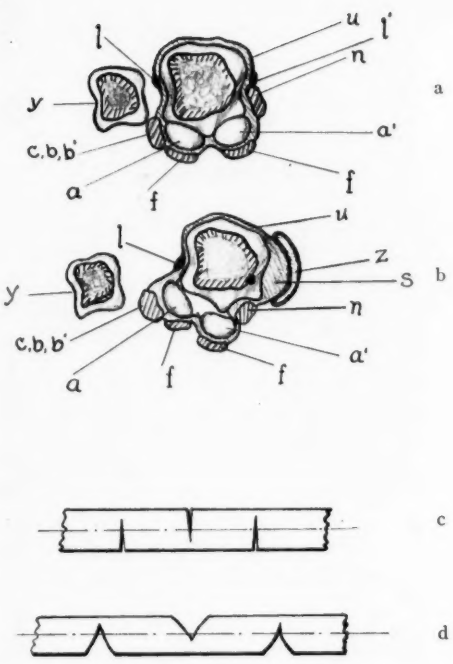


Fig. 3. a, Transverse section through head of normal first metatarsal bone. b, Similar section in a case of hallux valgus. *a*, *a'*, Sesamoid bones; *c*, *b*, *b'*, conjoined adductor hallucis tendon; *n*, abductor hallucis tendon; *f*, flexor brevis tendons; *u*, capsule; *y*, head of second metatarsal bone; *s*, fibrocartilaginous capsular thickening; *z*, overlying bursal sac; *l*, *l'* lateral ligaments.

The abductor hallucis muscle, in addition to its action in maintaining the alinement of the toe, also has a splinting effect on the first metatarsal bone. Acting in a line parallel to this bone, and using its head as a fulcral point, the abductor hallucis pushes this bone toward the second metatarsal. The adductors, arising from the remaining metatarsal bones, in opposing this action, tend to keep all the metatarsals together and in normal alinement.

This effect also is lost, as the abductor tendon goes plantarward, resulting in the development of metatarsus varus (Fig. 6). (Where the forefoot is supinated, the inner four metatarsals may be involved, as can be seen in Figure 7.) Later there is the occurrence of spreading of the metatarsal heads, and dropping of the anterior arch. Since the metatarsal of the great toe no longer is fixed, the remaining metatarsals likewise are not fixed.

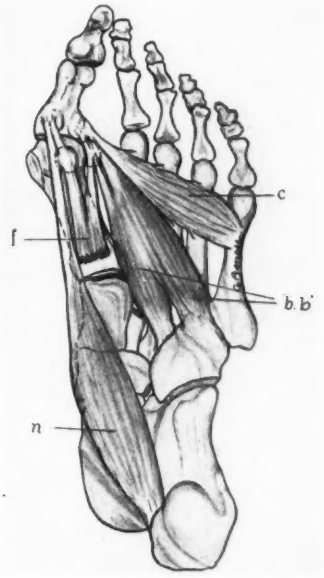


Fig. 4. Displacement of adductor and abductor muscle groups and sesamoids in hallux valgus. *n*, Abductor hallucis; *f*, flexor brevis; *b*, *b'*, adductor obliquus; *c*, adductor transversus.

With this concept, one may readily understand why in cases of hallux valgus there is usually found the co-existence of metatarsus varus, spreading of the metatarsal bones, depression of the anterior arch and displacement of the sesamoids.

PATHOLOGY

Following are described typical pathological changes to be found in the usual well developed case of bunions.

Fig. 5. Lateral displacement of sesamoids in hallux valgus.

Fig. 6. Varus of first metatarsal bones. Note marked increase in space between first and second metatarsal heads, indicating corresponding elongation of transverse intermetatarsal ligament.

Fig. 7. Varus of the inner four metatarsal bones. Note the comparatively slight spreading between the first and second metatarsal heads on the right side in spite of the marked first metatarsus varus.

Lateral aspect. 1. The capsule here is contracted in its longitudinal and transverse diameters. That part between external lateral ligament and external sesamoid is especially involved (Fig. 3b).

Fig. 8. Note the marked thickening and increased density of the capsule overlying the "bunion" joint, and the relatively small bony component of this enlargement.

2. The external lateral ligament is foreshortened.

3. The external sesamoid is displaced laterally and slightly dorsally into the interspace between the first and second metatarsal heads. Here it is firmly anchored by the contracted obliquus attachment, as well as the contraction of the capsule above its lateral margin (Figs. 3b and 4).

4. The lateral head of the flexor brevis is contracted.

Medial aspect. 1. The capsule here is the seat of marked, fibrocartilaginous thickening. Overlying this is a thin walled bursal sac (Fig. 3b).

2. The tubercle of origin of the internal lateral ligament is somewhat hypertrophied.

3. The abductor tendon is displaced inferiorly and laterally, dislodging the sesamoids (Figs. 3b and 4).

Associated changes. 1. The great toe is maintained in a position of valgus, eversion, and slight downward subluxation (Fig. 9).

2. There is an exaggerated varus of the first metatarsal, with a corresponding spreading and elongation of the transverse intermetatarsal ligament between it and the adjacent head (Fig. 6). (Frequently, however, especially in cases of supinated forefoot, the inner four metatarsal bones go into varus together, Fig. 7).

3. The metatarsal head is inverted in relation to the toe.

Fig. 9. Drawing of skin incisions. The eversion of the great toe is indicative of displacement of the abductor tendon into the groove for the medial sesamoid.

4. In advanced and long standing cases, there are secondary adaptive bony changes of the metatarsal head. These consist mainly of hypertrophy and "squaring" of its medial margin. This may be sufficiently marked to cause lateral shifting of the entire articular surface (Fig. 10).

5. In arthritic cases, there may be hypertrophy and lipping of the articular margins and sesamoids.

The so called "exostosis" removed at operation is usually a myth. On examination, it is found to consist essentially of a section of the inner margin of the normal or hypertrophied cartilage covered head, plus a segment of the markedly thickened, dense, fibrocartilaginous capsule, and the thin, overlying bursal sac. Roentgenographically, what clinically appears to be an exostosis directly under the skin, is found to be a dense, soft tissue enlargement (Fig. 8).

The "enlarged" joint, so commonly referred to in connection with these cases, is essentially an over-prominence of the head, due to the metatarsus varus, accentuated by the capsular thickening and the valgus position of the toe. The bony component of this enlargement is relatively small.

SURGICAL CONSIDERATIONS

From a surgical viewpoint, the problem of hallux valgus is similar to that of club foot or any

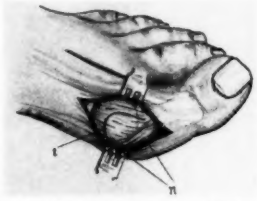


Fig. 11. *t*, Modified Silver capsular flap incision; *n*, abductor tendon.

Fig. 10. Hypertrophy of the mesial margin of the first metatarsal head, especially on the right side, sufficient to cause almost the entire articular surface to face laterally.

contractural deformity. The primary deforming elements are found on the contracted side.

The surgical requirements include: (1) on the lateral aspect, thorough division of the contracted deforming structures; (2) on the medial aspect, bursectomy plus capsuloplasty fashioned to replace the abductor tendon and correct the eversion and valgus of the toe; (3) removal of any obstructing bone from the metatarsal head.

The contracted structures on the lateral aspect consist of (1) adductor obliquus attachments to the lateral sesamoid, (2) the external lateral ligament, (3) the capsule between the two structures, (4) frequently, the lateral head of the flexor brevis muscle.

Their division is of primary importance. It permits unresisted correction of the valgus deformity and allows the sesamoids to slip into place. A main causative factor in recurrence is

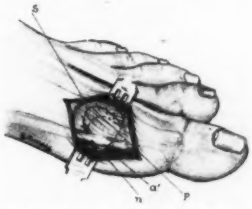


Fig. 12. Capsular flap in position of correction. *a'*, Medial sesamoid; *n*, abductor tendon; *p*, position of capsular flap before correction; *s*, position of capsular flap following correction and suture. Note the replacement of the abductor tendon. Correction of eversion of the great toe.

a b c d

Fig. 13. a and b, Both feet before operation. c and d, Both feet after operation. Note the spherical first metatarsal heads, the replacement of the sesamoids, the improved relationship of the first metatarsal internal cuneiform joints, and the diminished metatarsus varus.

eliminated. This procedure alone, without any additional work on the medial aspect, has yielded satisfactory results (Fig. 17c). This has been noted especially in cases of recurrence due to their inadequate division at the original operation.

Cases with secondary hypertrophic changes of the medial margin of the metatarsal head, acting as a bone block against complete correction, require removal of the obstructing one. This restores congruity of the articular surfaces.

In cases in which severe osteo-arthritic changes have taken place with lateral shifting of the articular surface (Fig. 10), the more radical resection operations are to be considered. However, if the symptoms are localized to the bursal region, the more conservative operations, directed at alleviation of pain only, are preferable.

The writer has found it inadvisable and rarely necessary to sever the conjoined adductor tendon from its insertion into the base of the proximal phalanx. The capsular incision to be described plus complete division of the lateral sesamoid attachments of the obliquus tendon and occasionally the lateral head of the flexor brevis answer the same purpose, i.e., of permitting unresisted correction of the valgus of the great toe. This procedure has the advantages (1) that the lateral muscle balance of the toe is preserved, (2)

Fig. 14. Attachments of the usual two obliquus heads to the lateral margin of the lateral sesamoids. Dotted line indicates line of incision for separating these structures from this sesamoid. *a*, Lateral sesamoid; *b*, *b'*, adductor obliquus heads; *c*, adductor transversus muscle; *f*, flexor brevis hallucis; *l*, external lateral ligament; *m*, medial incision; *x*, line of severance of adductor attachment to lateral sesamoid.

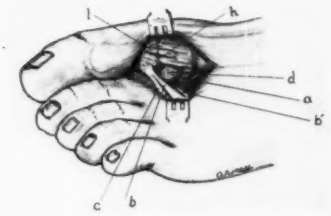


Fig. 15. Semi-oblique view to show deeper structures. Dotted area, *d*, indicates severance of obliquus attachments from lateral sesamoid. Note proximal head of obliquus, *b'*, only is divided completely. The heavy dotted line indicates line of "hockey stick" incision through lateral ligament and capsule between it and underlying sesamoid. *a*, Sesamoid; *b*, *b'*, adductors obliquus; *c*, adductor transversus; *h*, "hockey stick" incision; *l*, lateral ligament.

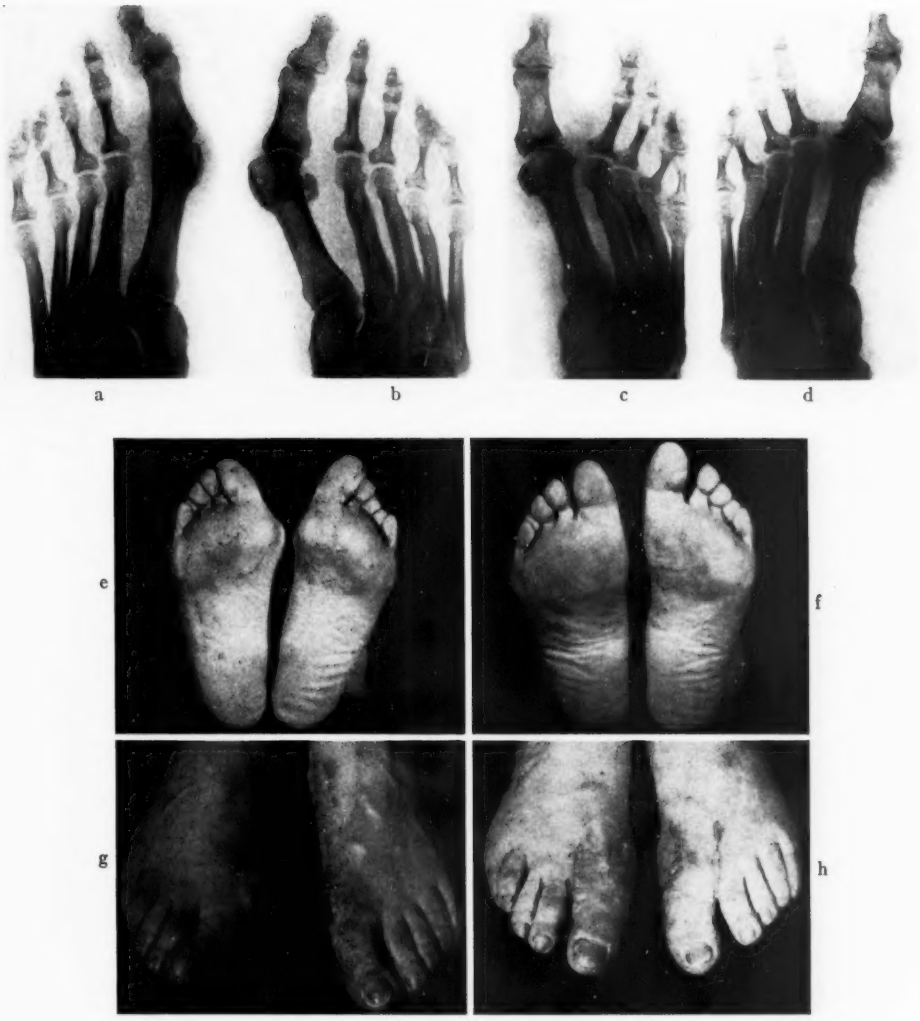
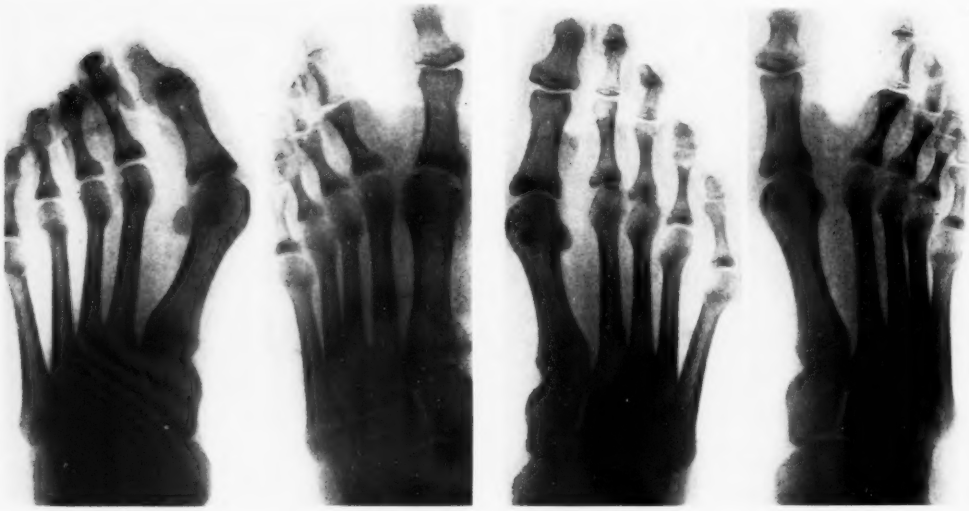


Fig. 16. a and b, Roentgenograms of both feet before operation; c and d, after operation; e and g, photographs of both feet before operation; f and h, after operation.

the lateral sesamoid is prevented from retracting, (3) control of the sesamoids via the great toe, so essential for their reposition, remains intact.

Similarly, the various plastic and fusion operations at the base of the first metatarsal for bony correction of its varus are objectionable in ordinary cases for the following reasons: (1) they result in diminished strength and flexibility of the longitudinal arch—especially the function of the ball of the big toe—; (2) unless fusion is accomplished at an exact angle, the ball of the big toe is caused to remain either too high or too low, with consequent secondary static disturbances; (3) an undesirable convergence of the first and second metatarsal bones may result; this is especially true when the varus involves all inner metatarsal bones (Fig. 7); (4) adequate spontaneous correction usually occurs after the valgus and eversion



a c b d

Fig. 17. a and b, Both feet before operation; c and d, after operation.

of the toe has been overcome, and the sesamoids replaced; (5) the "bony deformity" at this joint, in most instances, is more apparent than real. It is dependent on the degree of inversion of the forefoot, the angle at which the x-rays are taken, and the altered relationship of the joint surfaces (Figs. 13a, b, c, d).

Operations of this nature are reserved for those comparatively rare cases in which a definite bony deformity, or the presence of an intermesial bone, as described by Truslow, maintains an unyielding, exaggerated varus of this metatarsal.

OPERATION

Fungus infection, if present, is preliminarily treated.

Operation is performed preferably under a tourniquet. A longitudinal incision, about 1½ inches in length, is made on the dorsum of the foot, in the interval between the first and second metatarsal heads. This extends from behind the web directly posteriorly (Fig. 9).

Dissection is carried down, keeping close to the lateral aspect of the capsule, thus exposing the lateral sesamoid with its obliquus attachment, the conjoined tendon, and the lateral head of the flexor brevis muscle.

With the joint line as a guide, the external lateral ligament with the part of the capsule intervening between it and the lateral sesamoid is divided by a "hockey stick" incision (Fig. 15). This is begun by dividing the external lateral ligament at the joint line, carried downward, then posteriorly, in the interval between the lower margin of the head and the lateral sesamoid, and extended well back.

The attachments of the obliquus tendon to the now exposed lateral sesamoid are thoroughly divided. The hindmost fibers must be included. These usually are attached to its posterior tip as a separate bundle (Fig. 14). (The attachment of the conjoined tendon to the base of the proximal phalanx, distally, and the red fibers of the flexor brevis muscle proximally, act as guides to insure its complete division.) The conjoined tendon gains length. Frequently, the lateral head of the flexor brevis also requires division. This should be performed proximal to its sesamoid attachment. A definite "give" can be felt when the binding structures at the posterior sesamoid tip are released. It is but rarely that a triple subtotal section of the obliquus tendon is found to be necessary.

Unresisted correction of the valgus, without any tendency to spring back, or undue joint tension is now possible. The sesamoids slip into place voluntarily.

The heads of the first and second metatarsals are now approximated by means of a heavy silk or fascial suture. This is taken through the opposing aspects of their capsular bases, or through adjoining drill holes.

A second, dorsally curved, incision is now made on the medial aspect of the joint (Fig. 9), thus exposing the bursa, the thickened fibrocartilaginous capsule, and the displaced abductor tendon.

The bursal sac is excised. A modified Silver capsular flap is so fashioned as to permit foreshortening of the elongated capsule, derotation of the everted toe, and replacement of the displaced abductor tendon (Figs. 11 and 12).

Before anchoring this corrective flap into position, the head of the metatarsal is inspected. If hypertrophy along its medial margin is sufficient to act as a bone block against complete correction of the valgus, or to result in undue joint tension after correction, the obstructing bone only, (mostly dorsomedially), is chiseled away. As far as possible, the ball of the toe, the groove for the medial sesamoid, and the inner cartilaginous rim at the periphery are conserved. The tubercle of origin of the internal lateral ligament, if enlarged, as well as any osteophytic processes, is removed.

If, after correction of the valgus, the extensor tendons are short, these may be corrected by triple subtotal sections (Figs. 3c and d).

Holding the toe in the desired degree of correction and in neutral position, the capsular flap is now anchored snugly. Silk sutures are preferable (Fig. 12). Overcorrection is avoided. Freedom of mobility should be possible before and after the anchoring sutures are applied.

The skin incisions are closed, and dressings and adhesive support are applied. No plaster-of-Paris cast is necessary.

Postoperative care includes active exercises. Weight bearing is permitted after 2 weeks. A Jones bunion splint is worn at night for several months. Static foot disturbances are treated and properly fitting postoperative bunion last shoes are prescribed.

REPORT OF CASES

A series of fifteen cases have been operated upon by this method, first utilized in 1933. Three illustrative cases are presented:

CASE 1. E. L., aged 42 years, with painful bunions of 7 years' duration (Figs. 16, a and b, and c and g). The procedure described was performed on both sides. Figures 16c and d, f and h show postoperative corrections. Note the corrected position of the sesamoid bones. Result 1 year after operation was very satisfactory.

CASE 2. M. T., aged 12 years, with painful bunions of 1 year's duration (Fig. 17a and b). This procedure was performed on the left side (Fig. 17c). On the right side, nothing but division of the obliquus tendon from the sesamoid and the capsular incision was done. Satisfactory correction was maintained in a 1 year follow-up study (Fig. 17d).

CASE 3. L. H., aged 15 years, painful bunions of 1 year's duration. The procedure described was performed on both sides. Satisfactory correction was maintained in a 3 year follow-up study (Figs. 13, c, d).

SUMMARY AND CONCLUSIONS

Some of the more pertinent features of the etiology, anatomy, physiology, pathological physiology, and pathology of hallux valgus have been outlined. This included: (1) a conception of the mechanism of the development of hallux valgus deformity; (2) the importance of the abductor hallucis tendon in maintaining the integrity of the forefoot; (3) the rôle of the contracted structures on the lateral aspect, and especially the obliquus attachments to the lateral sesamoid in the causation and in the recurrence of the deformity; (4) a discussion of the "exostosis" myth.

The importance, in the surgical correction of hallux valgus, of replacement of the sesamoids, after their preliminary thorough mobilization has been stressed.

An operative procedure, which, in the author's opinion, seems best suited to meet the surgical requirements, has been described and illustrative cases presented.

The author wishes to express his indebtedness to Dr. E. Haboush for his assistance in the experimental work, and to Mr. George Asness for illustrations and diagrams.

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THE VALUE OF DELAYED SINGLE PEDICLE SKIN FLAPS IN PLASTIC REPAIR OF THE SCALP

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An extensive raw surface in the scalp area, whether due to a deep burn, some degree of avulsion or other severe trauma, is usually healed with difficulty. Blair, Brown, and Byars have secured splendid results by their method of using thick split grafts. For avulsion of the scalp W. D. Haggard regards Thiersch and Reverdin or pinch grafts the only ones applicable. In an avulsion case, A. G. Banks found Thiersch grafts to be only partly successful, and later used a caterpillar graft from the abdomen to the forearm, thence to the scalp successfully. In an avulsion case, G. F. Mitchell closed a denuded area of the cranium 6 inches in diameter by the use of a series of multiple double pedicle flaps and some small single pedicle flaps.

From the Department of Surgery, Jefferson Hospital.
Read at the sixth annual meeting of The Society of Plastic and Reconstructive Surgery, St. Louis, Missouri, October 22, 1937.

In the very extensive scalp defects extending over the vault of the cranium, from one side to the other, one is apt to be content if a healed surface is secured by any method of skin grafting or even grafts plus cicatrization, without particular regard to the cosmetic result obtained, since some type of wig can be utilized to hide a disfiguring result.

If a large scalp defect, however, is limited to one side of the head, one should carefully consider the ultimate cosmetic result when the plan of plastic repair is outlined. In such cases, I strongly advocate the use of one or more delayed single pedicle flaps from the sound portion of the scalp as the major part of the operative procedure, supplemented, if necessary, by buried pinch grafts, Thiersch or split grafts, to cover any remaining wound surface. The area from which a large delayed pedicle flap has been swung, should be

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. M. A. January 9, 1936. Granulating wound 29 months after partial destruction of scalp by a hot air hair dryer.

Fig. 2. April 16, 1936. Appearance of burned area 52 days after the delayed single pedicle flap was placed in position across the midportion of the granulating surface. Buried pinch grafts were placed in the granulations above and below the flap, 14 days before the flap was moved to present location. Flap held perfectly. Epithelization above flap complete, while that below flap is not entirely complete. Some areas of scar tissue unstable, melting away at time of menstrual periods, then reforming.

Fig. 3. April 16, 1936. Scalp healed. Area above pedicle flap shows result from buried pinch grafts. Area on left side, from which pedicle flap was swung, shows result obtained by full-thickness skin graft from abdomen.

Fig. 4.

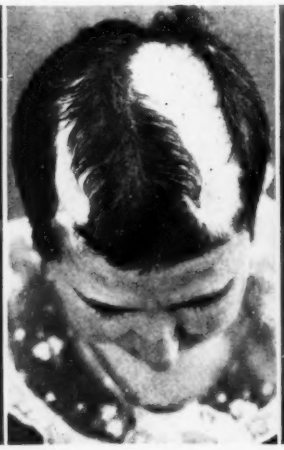

Fig. 5.

Fig. 6.

Fig. 4. September 9, 1936. Appearance 64 days after delayed pedicle flap was swung from occipital region to cover the unstable area below the first flap, shown in Figure 2.

Fig. 5. September 9, 1936. Further improvement in texture of grafted area.

Fig. 6. September 25, 1937. Amount of scar in area from which second flap was swung.

immediately covered with an accurately cut full thickness free skin graft from the abdomen.

The method of combining the several types of skin grafting will be described and the results obtained shown by a series of photographs of an old unilateral burn of the scalp thus treated.

CASE H-1045. M. A., female, aged 40 years (Fig. 1); referred by Dr. L. C. Darrah, Reading, Pennsylvania, January 6, 1936, 29 months after a burn of the right temporal and parietal areas and part of the anterior occipital and posterior frontal regions, by an electric hot air hair dryer, which cooked the scalp of the whole area to the periosteum and in some points to the bone. The heating coil in the dryer was out of order, but the increasing heat was so gradual that the high degree was not realized until the hair caught fire. Tannic acid was used in the primary treatment, followed by varying periods of treatment with benzocaine ointment, salt solution irrigations and compresses, boric acid solution compresses, and a gentian-violet tragacanth mixture. As the months passed, the

Fig. 7.

Fig. 8.

Fig. 7. September 25, 1937. When hair is combed the occipital scar is invisible.

Fig. 8. September 25, 1937. Hair arranged to show final appearance of grafted areas and hair dressed.

bone and periosteum became covered with a thin layer of vascular granulations which had a tendency to develop a very delicate unstable cicatricial surface which partly, or sometimes completely, disappeared during the menstrual periods.

In the planned repair, a pedicle flap, 2 inches wide, was outlined over the left side of the top of the head, extending from the occipital region to a point just posterior to the frontal hairline. Measurements insured sufficient length for it to be swung across the midportion of the wound later and sutured to the skin margin anteriorly. The flap was elevated, *both* ends being left attached, then replaced, and sutured into its original position. One week later the anterior attachment was divided, the flap elevated to the occipital attachment, and again replaced and sutured. After another week's delay, the flap was elevated, swung across the midportion of the burned area, and sutured into position. A free full thickness skin graft, the exact size of the pedicle flap, was taken from the abdomen and used to cover the area from which the delayed flap had been removed. At the time of the primary loosening of the flap, small pinch grafts, taken from the thigh, had been buried in the thin granulation tissue above and below the area to be occupied by the flap. All areas healed well, as shown in Figures 2 and 3.

During the following 3 months, it was observed that the healing in the area below the pedicle flap was not entirely stable, small points melting away at menstrual periods, serous fluid oozing out for 3 or 4 days then healing again. This did not occur on the area above the flap covered area. To secure satisfactory scalp tissue to cover the unstable area, a twice delayed single pedicle flap was then prepared in the midline of the posterior portion of the scalp, in the same manner as that used for the first flap, extending from the crown of the head to the margin of the scalp in the cervical area. One week after the second elevation of the flap, the thin unstable epithelium was removed from the area below the first flap, and the second flap placed in position and sutured. By widely undermining the skin margins about the area from which the second flap was taken, and by making a lateral incision at the upper and lower extremities of the raw surface, rectangular flaps were formed, and, by means of traction sutures, were advanced sufficiently almost to cover the raw area. All areas healed promptly and have remained stable (Figs. 4 and 5). It has been interesting to observe that the hair on the transplanted flaps has grown more rapidly and is more lustrous than that on the rest of the scalp.

The functional results have been entirely satisfactory; the cosmetic results are as shown in Figures 6 to 8. The patient is happy with the perfectly comfortable scalp and freedom from the necessity of any artificial covering or wig.

The method outlined is favored for these reasons:

1. A delayed pedicle flap develops an adequate blood supply, thus is more certain to live than is any type of free graft.

2. The thickness of the new scalp is nearer normal and does not develop atrophic spots on the surface.

3. Any surrounding scar tissue is more stable than it would be around any type of free graft.

4. The outline of the flaps can be planned so as to give symmetry in the distribution of hair bearing scalp surface, thus insuring better cosmetic results.

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CARCINOMA OF THE BRONCHUS

A Clinical and Pathological Study of 164 Cases

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THE recognition and treatment of primary carcinoma of the bronchus has assumed a rôle of increasing importance. Although many recent papers report an actual increase in carcinoma of the bronchus, greater diagnostic accuracy, more complete examinations including bronchoscopic study and removal of tissue for biopsy must not be overlooked —also the fact that individuals are now living longer as compared with twenty years ago. Graham (12) states: "The fact that the pathologists are now recognizing more of the small obstructive tumors instead of stopping their examinations at the complications, in my opinion, accounts for much of the present impression that bronchiogenic carcinoma has actually greatly increased in frequency in recent years." Regardless of whether or not the increase is real or apparent, carcinoma of the lung is a relatively common disease.

INCIDENCE

Brunn, in a statistical analysis of necropsy reports from 1898 to 1916, found 488 primary carcinomas of the lung in 192,271 necropsies, or 0.24 per cent. From 1916 to 1924 there were 71 cases in 33,308 necropsies, or 0.21 per cent. He mentions figures prior to 1900; however, it is difficult to evaluate reports of this period since so little stress was placed upon lung diseases at that time.

Rogers reported 50 cases of primary lung cancer found in 2,209 autopsies done on persons 30 or more years of age at the Pathologico-Anatomic Institute of the University of Vienna from October, 1929, to November, 1930. The incidence in this group was 2.26 per cent.

Rosedale and McKay reported that in 4,670 autopsies in the period 1925–1934, 466 malignant neoplasms of all types were found, and of this number 7.5 per cent were bronchiogenic carcinomas.

Jaffe (14) in 1935 reported 871 carcinomas in 6,800 autopsies; of this number 11.47 per cent were carcinomas of the lung. In 1921, in a statistical analysis of 4,500 autopsies performed between 1915 and 1918 in Vienna, also reported by Jaffe (15), the incidence of carcinoma of the lung among the carcinomas was 10.73 per cent. In these reports the slight increase is more apparent than real.

A study of primary admissions to the Hines Hospital in the 6½ year period from January 1, 1931, to July 1, 1937, reveals a definite increase in primary carcinoma of the bronchus. In Table I are figures comparing the number of primary carcinomas of the bronchus each year with 4 other types of carcinomas as well as with all admissions for carcinomas during a 6 year interval.

This report is based upon an analysis of the clinical features presented by 164 patients having primary carcinoma of the bronchus in whom the diagnosis was established by postmortem examination (100 cases), by histological examination of tissue removed through the bronchoscope (21 cases), by other biopsy examinations (13), or by clinical and roentgen-ray evidence (30 cases). In each instance, the end-result is known constituting a 100 per cent follow-up.

SEX

An analysis of 549 cases reported by various authors from the literature shows the ratio of males to females to be 5.6 to 1, respectively.

Regarding this item, Brunn in his statistical analysis of 576 cases published in 1926 states:

TABLE I.—INCIDENCE OF PRIMARY CARCINOMA OF BRONCHUS

Male wards	1931	1932	1933*	1934	1935	1936
Carcinoma—bronchus	7	16	16	24	32	45
Carcinoma—larynx	17	17	8	17	17	24
Carcinoma—lip	87	112	59	79	79	94
Carcinoma—rectum	22	25	10	27	35	44
Carcinoma—stomach	26	32	17	35	42	54
All admissions for carcinomas	406	580	297	462	591	694
Per cent, carcinoma—bronchus compared with all carcinomas	1.7	2.8	5.4	5.2	5.4	6.5

*Because of economy measures, a marked reduction in admissions occurred in 1933.

From the Tumor Clinic and Tumor Research Unit, Veterans' Administration, Hines, Illinois.

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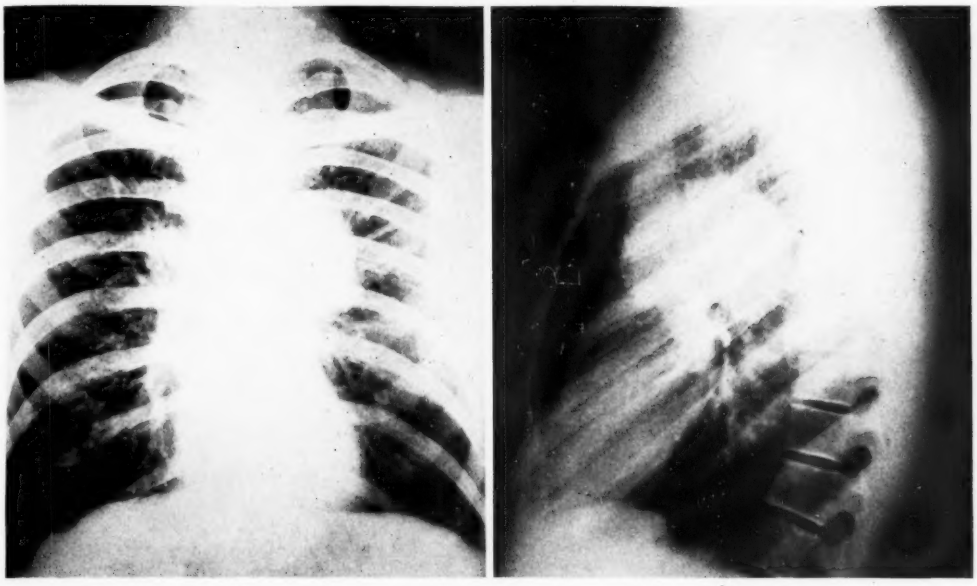


a b

Fig. 1a. Bronchiogenic carcinoma, left upper lobe, resembling aneurysm of aorta.

Fig. 1b. Lateral view, same case. A well defined circular shadow, apparently not contiguous with the vascular shadow, is noted which suggests mediastinal tumor rather than aneurysm.

"The disease occurs much more frequently in men than in women, almost in the relation of 75 per cent in males to 25 per cent in females." In our study of 549 cases compiled since 1926 the relation is 85 per cent in males to 15 per cent in females.

AGE

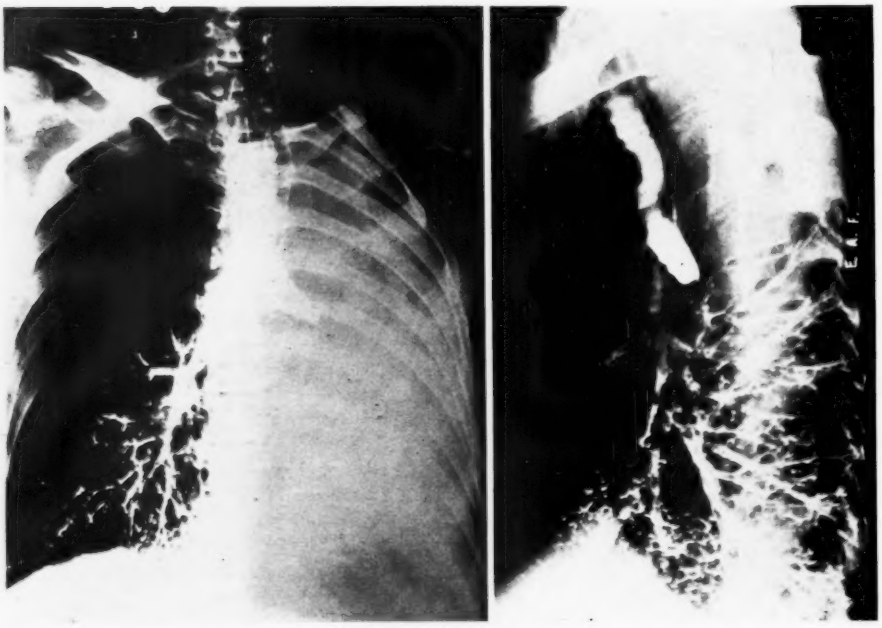
Regarding age an analysis of 364 cases, including 164 cases reported in this paper, reveals that the majority of cases occur in the interval between 40 and 60 years. Adding our figures to those of Brunn (4), making a total of 940 cases, 65 per cent were between 40 and 60 years. This was also reported in a study of 96 cases at the Mayo Clinic where 61 per cent were found to be between 40 and 60 years of age. In our group of primary carcinoma of the bronchus, the range in age at the time of admission to the hospital was from a minimum of 33 years and 7 months to a maximum of 68 years and 1 month, the average or mean age being 45 years and 7 months. The range in ages at time of onset of symptoms in a group comprising 140 where onset could be determined with reasonable precision was from a minimum of 32 years and 1 month to a maximum of 67 years and 6 months, the average or mean age at onset of symptoms being 45 years and no months.

RACE

In this series of 164 cases of carcinoma of the bronchus, 154 were white men and 10 colored. In the 57 cases reported by Rosedale and McKay, 51 were white and 6 colored. Arkin and Wagner had 12 colored patients in their series of 135 cases. Jaffe (14) found that the total incidence of pulmonary carcinoma was higher in the white race than in the colored race, namely, 1.7 per cent of all autopsies in the white race and 1.0 per cent of all autopsies in the colored race.

FAMILY HISTORY

Although the family history was not recorded in 16 cases, in the remaining 148 cases the findings were interesting inasmuch as in 28 cases (31 instances of carcinoma), or 19 per cent, there was a family history of cancer, and in 11 cases (12 instances), or 7.4 per cent, there was a family history of tuberculosis. In 3 cases there was a family history of both tuberculosis and cancer, namely, in 2 cases the mother had died of tuberculosis and the father of carcinoma of the stomach, respectively. In the third case a brother



Figs. 2a and 2b. Anterior and lateral views of bronchiogenic carcinoma, showing collapse of the lung and complete obstruction of left main bronchus just distal to the bifurcation.

died of pulmonary tuberculosis and the mother of carcinoma of the bladder. Vague histories, such as "father died of chronic lung trouble," were not included. With more authentic or definite information, it is thought the figures might be slightly higher.

OCCUPATION AND ETIOLOGY

Although an exhaustive study was made of the various occupations in this group, no conclusions of any significance could be drawn. At least 75 different occupations were represented, the largest group being farmers or common laborers. Eight, or 5 per cent, of the patients had been coal miners but 4 of these also had been employed in other occupations. In addition there were 2 patients whose occupations conceivably might have had some bearing upon the disease. One patient had worked originally as an ore miner, later as a metal polisher and motor assembler. A second patient had been employed for 7 years as an emery polisher inhaling fine particles of emery dust.

Rosedale and McKay state that 75.4 per cent of the patients listed in their group of 57 were employed in occupations requiring exposure to dust or other irritating atmospheric factors. It is difficult to evaluate properly the part that dust and irritative atmospheric factors play in the etiology of carcinoma of the lung, especially in patients coming from large cities or industrial centers. There have been no conclusive facts shown as yet to prove that the above are of major importance.

Theoretically, trauma is to be taken into consideration in speculating upon etiology. In this series of cases there was no history of injury of any significance. However, among these veterans there were 8 who had been subjected to war gas with resulting residuals and complaints of dyspnea, cough, pleurisy, bronchitis, recurrent attacks of pneumonia. In the latter instance one patient stated that in the attacks of pneumonia, the left lung had always been the involved lung. Later he developed carcinoma of the left main bronchus. With the exception of 2 cases, both of whom underwent mustard gas poisoning, the type of gas is not mentioned in our histories. One of these patients was the individual previously mentioned who later was employed as an emery polisher, so that there are further theoretical complications and conjectures regarding etiology in his case. The entire subject of exposure of

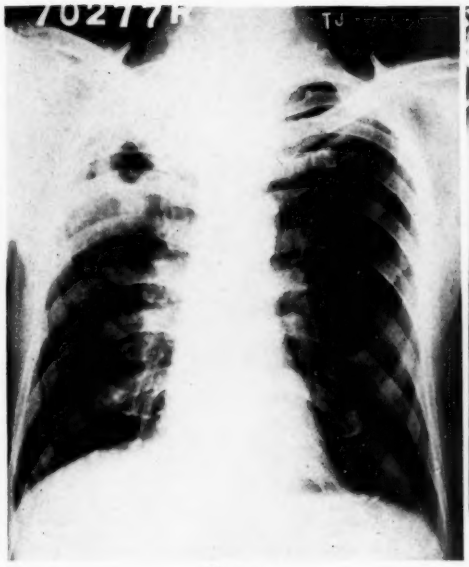


Fig. 3a

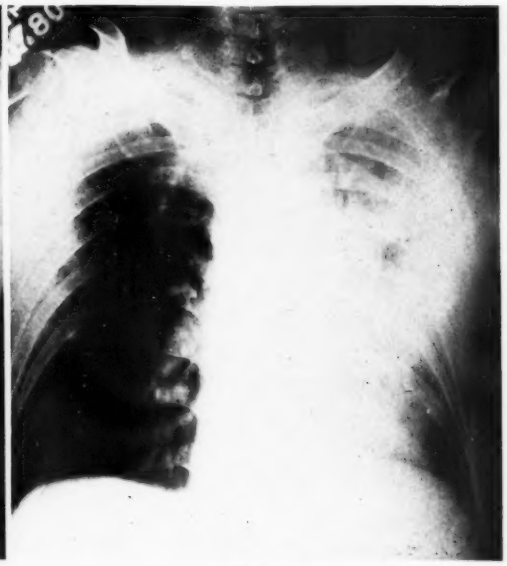


Fig. 3b

Fig. 3a. Bronchiogenic carcinoma, right upper lobe, complicated by secondary abscess.

Fig. 3b. Bronchiogenic carcinoma, left upper lobe, complicated by extensive secondary infection. While the multiple abscesses dominate the picture, the x-ray features of bronchostenosis are also demonstrated.

Fig. 3c. Bronchiogenic carcinoma, left upper lobe, complicated by large secondary abscess. X-ray features of bronchostenosis are also noted in this case. Figures 3a, 3b, and 3c illustrate the difficulties encountered in diagnosis when secondary infection is present.

veterans to various types of gas during the World War has been very thoroughly discussed by Gilchrest and Matz.

Although reports have been made stating that tarred streets predispose to the formation of carcinoma of the lung, yet the incidence is just as high where these conditions do not exist. Allen is of the opinion that carcinoma of the lung is no more common among the coal miners of Pennsylvania than in the other population of Pennsylvania.

SYMPTOMS

The symptoms of carcinoma of the bronchus are the result of bronchostenosis with its associated pathology, ulceration of the mucosa, or extension of the tumor. Atelectasis is commonly associated with obstruction of the bronchus. Later bronchiectasis develops and abscess formation. As a result of this pathology, there will be pain, cough, dyspnea, and scant or profuse purulent sputum. If a blood vessel is injured as a result of ulceration of the bronchial mucosa, hemorrhage may be produced or the sputum streaked with blood. Chills, fever, and leucocy-

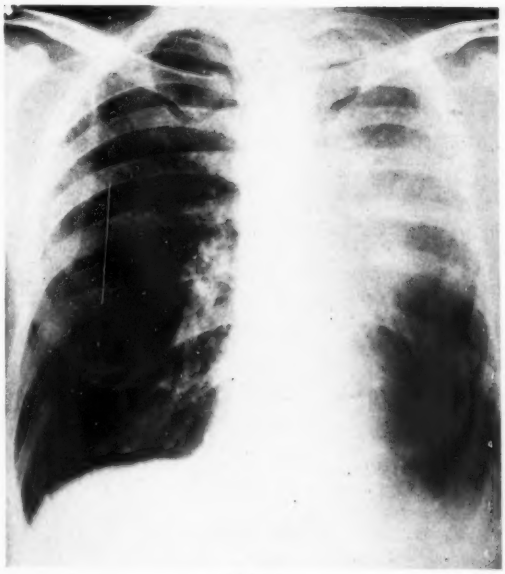


Fig. 3c

Fig. 4. Bronchiogenic carcinoma, right lower lobe, demonstrating characteristic x-ray findings with atelectasis of this lobe.

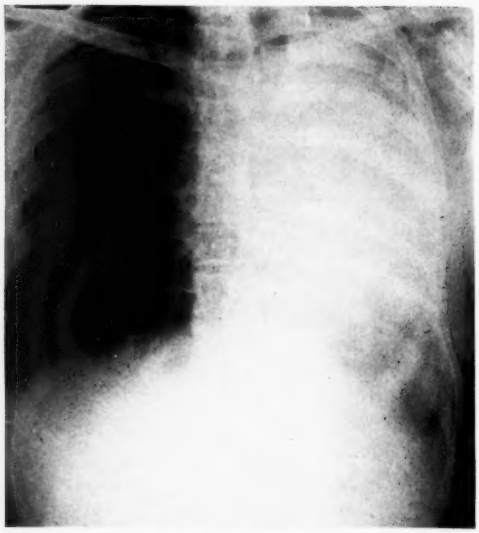


Fig. 5. Bronchiogenic carcinoma, demonstrating x-ray findings with complete obstruction of left main bronchus. Note shift of mediastinal structures to affected side.

tosis are caused by the formation of abscesses about the tumor and are generally seen late in the disease. More than half of the patients will have fever at a late stage in the disease.

Funk, in reporting 61 cases, states the onset of symptoms was usually insidious, although there were also many with sudden pain in the chest, hemorrhage, dyspnea, or symptoms resembling

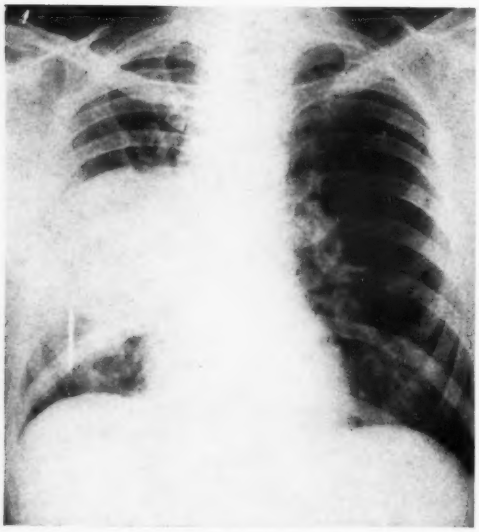


Fig. 6. Bronchiogenic carcinoma. Characteristic x-ray appearance. Complete obstruction of middle lobe bronchus.

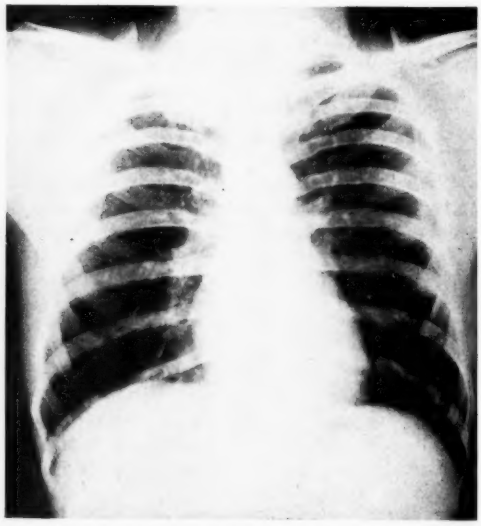


Fig. 7. Superior sulcus tumor, right apex (Pancoast type), producing partial destruction of second rib.

TABLE II.—PRINCIPAL SYMPTOMS

Symptom	No. of cases	Symptom	No. of cases
Cough	131	Night sweats	25
Loss of weight	129	Anorexia	26
Chest pain	127	Heart palpitation	19
Dyspnea	110	Dysphagia	16
Weakness	105	Orthopnea	8
Expectoration	72	Pain other than chest:	
Blood streaked sputum—hemoptysis	72	Hip, leg, various joints	17
		Shoulder	17
		Arm	17
		Head	14
Gastro-intestinal discomfort	32	Back	14
		Abdomen	7
Hoarseness	29		

TABLE III.—PHYSICAL FINDINGS

Physical signs	Number of cases
Dullness	137
Diminished breath sounds	117
Restricted mobility	113
Râles	88
Diminished fremitus	65
Nodes positive	57
Pleurisy (including pleural effusion)	52
Abdominal changes	46
Atelectasis	40
Chest wall or cervical vessels engorged	33
Vocal cord changes	25
Eye changes—choked discs or other significant changes	25
Clubbing of fingers	16
Horner's syndrome	7

acute bronchitis. In one-third of his patients the onset was not unlike an acute respiratory infection.

Approximately one-third of our patients also described their initial symptom as "heavy cold," "flu," "chill and fever," or had been diagnosed "pneumonia" or "pleurisy." A few additional patients described early symptoms as "asthma" or "bronchitis." In Farrell's cases, the initial symptom had been present a year in more than half the patients before a physician was consulted.

The principal symptoms noted in the cases at this hospital are shown in Table II.

Comparing the symptoms in these cases with those enumerated in other reports, cough, loss of weight, dyspnea, chest pain are most commonly found. However, loss of weight is generally not an early complaint.

The physical and roentgen observations are most often the result of associated pathological conditions, such as bronchitis, abscess, bronchiectasis, pleurisy with or without effusion, atelectasis, et cetera. Quite often the tumor may be obscured by associated pathological conditions and the diagnosis made difficult upon x-ray examination.

The most significant physical findings in our cases are shown in Table III.

ROENTGENOLOGICAL FINDINGS

The findings when typical are that of a unilateral density in the hilum with its apex directed toward the periphery of the lung. Quite often the lateral border of the density blends in with the veil-like shadow of the atelectatic lung resulting from the bronchostenosis. The ribs are narrowed on the affected side, the trachea pulled to that side and the diaphragm elevated. The entire hemithorax is smaller than that of the opposite side. Atelectasis is one of the most common findings in the lung secondary to tumor formation. Occasionally the shadow of the tumor cannot be distinguished from that of the atelectatic lung. When complete obstruction of the bronchus has taken place, the air distal to the obstruction is absorbed and the lung collapses as a result. Bronchiectasis may follow the atelectasis. If the growth is located in the region of the apex of the lung, having no connection with the hilum and causing erosion of ribs or vertebræ, a carcinoma of the terminal bronchioles should be suspected (so called Pancoast type of tumor). Recently one of the authors of this paper (JJS, 24) reported a series of 8 cases of carcinoma of the apex of the lung (so called superior pulmonary sulcus type). Six of the cases were in the right apex and 2 in the left apex. Histological specimens were obtained in 5 of the cases; 3 were squamous cell carcinomas and 2 adenocarcinomas. The 3 remaining patients are still living. It is interesting to note that 3 of these cases had been previously diagnosed as tuberculosis and 1 as neuritis.

A large number of the far advanced cases have many associated complicating pathological factors which confuse the picture. Bronchiectasis, abscess cavities, pleural effusion and lymphadenopathies may overshadow the lesion in the hilum. Metastatic lesions in the lung are generally multiple, seldom produce pulmonary symptoms until late, and rarely cause bronchostenosis. That a metastatic lesion may, however, simulate a primary carcinoma of the bronchus was dramatically shown by a case of hypernephroma recently observed by the authors, in which a single metastatic lesion in the lung surrounding an upper lobe bronchus produced a bronchostenosis with the characteristic roentgen-ray findings of a primary carcinoma of the bronchus. The metastatic nodules have a smooth outline as compared with the irregular single shadow of the primary

TABLE IV.—INVOLVEMENT AT AUTOPSY (100 CASES)

Organ	No. of cases	Organ	No. of cases
Liver	41	Intestine	1
Adrenal	31	Periosteum-skull, clavicle (bone not invaded)	1
Contralateral lung	30	Stomach	1
Kidney	25	Thyroid	1
Pleura	20	Trachea	1
Heart or pericardium	19	Nodes	
Bone*	15	Tracheobronchial	63
Brain†	11	Retroperitoneal	27
Pancreas	10	Mesenteric	26
Spleen	6	Supraclavicular	9
Diaphragm	6	Cervical	6
Epiglottis or larynx	1	Paravertebral	6
Esophagus	1	Axillary	5

*Only 18 of the 100 cases specifically examined for bone metastases.
†Only 14 of the 100 cases specifically examined for brain metastases because of restricted consent.

lesion. If an extensive pleural effusion is present, additional films should be made after paracentesis.

HISTOLOGICAL AND PATHOLOGICAL FINDINGS

Often it is quite difficult properly to classify tumors of the lung in that the cellular structure varies a great deal and simulates other forms of malignancy. Samson, in a survey of 100 cases of bronchiogenic carcinoma in which complete autopsies were done, classified the cases as to cell type and found 51 per cent to be adenocarcinoma, 30 per cent squamous celled, and 19 per cent undifferentiated carcinoma. In Farrell's series of 50 cases, 23 were squamous celled carcinomas, 3 adenocarcinomas, and 24 undifferentiated carcinomas. In a series of 100 cases specifically studied at Hines Hospital as to cell structure, the histological classification was 36 squamous cell carcinomas, 35 adenocarcinomas, and 29 undifferentiated carcinomas.

The major bronchi near the tracheal bifurcation are lined by stratified epithelium. With the decrease in size of the bronchi from the tracheal bifurcation to the periphery of the lung, there is an associated decrease in size of the epithelium, the cells of which become thinned out and less spindle-shaped. At the ductus alveolaris the cells are cuboidal. The exact origin of the alveolar lining cells has not been determined. Lemon and Higgins (17) consider the alveolar lining cells to be histocytes and mesenchymal in origin. Fried (8) also believes that the alveolar cells are of mesenchymal origin and that "the epithelium of the bronchiole ends abruptly and is followed by the 'naked' walls of the air sacs."

TABLE V.—BONES INVOLVED

Bone	Number of cases
Ribs	10
Vertebræ	5
Femur	3
Humerus	1
Ilium	1
Skull	1

The mucous glands in the wall of the bronchi apparently take their origin from the bronchial epithelium and their ducts are lined with ciliated cells which are continuous with the cells lining the lumen of the bronchus. Since the epithelial elements have the same embryological background, all carcinomas of the lung probably arise from the lining cells of the bronchi. Samson has noted that the type of cellular structure in carcinomas of the bronchus depends upon the kind and degree of differentiation attained and not upon the level of origin in the respiratory tract. The cells of the less differentiated basal layer of the bronchus epithelium have the capacity to produce squamous epithelium, columnar epithelium, or undifferentiated round or spindle cells. The 3 types are squamous celled carcinoma, adenocarcinoma, and undifferentiated carcinoma.

It is not definitely known just what part silicosis, bronchitis, bronchiectasis, and other chronic diseases play in the etiology of carcinoma of the lung. The metaplastic changes which the lining cells undergo in these conditions are for a protective purpose rather than as a forerunner of carcinoma. Similarly when the endometrium is everted, the cells become squamous as a protective measure. The great majority of primary carcinomas of the lung arise from the bronchial mucosa. A large percentage of the cases take origin from the epithelium of a bronchus of the first order.

The involvement of various organs as noted in 100 autopsied cases is given in Table IV.

In addition, in unautopsied cases there was clinical or x-ray evidence of brain metastases in 19 cases; of bone metastases in 14 cases; in 3 of metastases to skin—1 of the chest wall—1 of the abdominal wall—1 of the arm, thigh, and abdominal wall; 27 of superficial glands; 3 of mediastinal glands; 1 of abdominal glands; 2 of metastases to opposite lung.

The frequency and location of bones involved in 15 autopsied cases having bone metastases are indicated in Table V.

TABLE VI.—LOCATION OF CARCINOMA IN LUNG (100 AUTOPSIED CASES)

Right side	No. of cases	Left side	No. of cases
First order	43	First order	30
Trachea, carina and first order	2	First order and carina	1
First and second order	1	Second order	2
First order and carina	2	Grossly diffuse	2
Second order	6	Origin undetermined	1
First, second and third orders	1		
Terminal bronchioles	3		
Grossly diffuse	4		
Origin undetermined	1		
Both sides First order and carina	1		
Summary Right: 63		Left: 36	Both sides: 1

Brunn in a study of 626 case reports, found the heart to be involved in 21 per cent of the cases and the suprarenals in 14 per cent.

The location as finally determined from an examination of autopsied cases demonstrated a greater incidence of cancer in the right bronchus than the left. This corresponds to findings reported by others. The precise location (cases coming to autopsy) is given in Table VI.

Table VIII shows the co-existing diseases or conditions which were found in an analysis of these cases.

With regard to tuberculosis, we are of the opinion that tuberculosis in the presence of carcinoma is a coincidence. It is difficult to believe that either disease causes the formation of the other in the same person. Jaffe (14) found that 7 of his 100 autopsied carcinoma of the lung cases also had tuberculosis. However, there was no case of carcinoma formation from the metaplastic epithelium of an old tuberculous cavity. In many cases of early tuberculosis, the patients consult the physician because of a "generally run-down" feeling, loss of appetite and fatigue following slight exertion, whereas in cases of early carcinoma of the lung the most common symptoms are pain in the chest, cough, and dyspnea.

Syphilis of the lung is rare and quite difficult to diagnose, and such a diagnosis is generally always made by excluding all other possibilities. In 6 of the cases in our series, there was definite evidence of syphilis, but in no case was there evidence of syphilis of the lung.

TABLE VII.—ASSOCIATED LUNG PATHOLOGY FOUND AT AUTOPSY

	Number of cases	
Abscess of lung, single, multiple		18
Atelectasis		7
Atelectasis with bronchiectasis		1
Bronchiectasis		1
Bronchitis		4
Emphysema		7
Empyema		3
Pleurisy		40
Fibrinous	2	
Fibrous	24	
Hemorrhagic	1	
Pleural effusion and hydrothorax including 1 with pericardial effusion also	10	
Serofibrinous	1	
Serohemorrhagic	1	
Suppurative	1	
Pneumonia		29
Bronchopneumonia	13	
Lobular	15	
Lobar	1	
Pneumoconiosis—anthracotic		2
Pneumoconiosis—moderate		5
Anthracosis—marked		1
Thrombosis, pulmonary		2
Tuberculosis, lung		4
Tuberculosis, hilum nodes		2

TABLE VIII.—CO-EXISTING DISEASES

Pneumoconiosis	7 (autopsy)
Pulmonary tuberculosis	7 (4 autopsy)
Syphilis	6 (positive serology)
Diabetes mellitus	2 (1 autopsy)
Hypernephroma	1 (autopsy)

Brain involvement. All adults having symptoms of involvement of the brain from any cause should have roentgen-rays made of the chest. Jaffe (14) found involvement of the brain in 19 cases in his series of 100 autopsied cases (in 23, brain was not examined). In our series of cases there was clinical or autopsy evidence of cranial metastases in 30 cases. In 4 of our cases there was no history referable to the chest. One of the 4 patients was operated elsewhere for brain tumor because of history of headaches, convulsions, and vomiting. No chest roentgen ray had been made. In an interesting report by Fried and Buckley (9) in 1930, central nervous system metastasis was found in 15 of 37 cases of bronchiogenic cancer. A diagnosis of brain tumor was made in 11 of the 15 cases and intracranial operations performed.

TREATMENT

Since many of the cases were far advanced upon admission to this hospital, irradiation was frequently the only possible choice of treatment. In some instances, this was contra-indicated because of patients' generally poor condition, leucopenia, et cetera.

Surgical extirpation of a centrally located growth must include removal of the entire lung and hilum, as well as the adjacent mediastinal lymph nodes. If the lesion is peripherally located, lobectomy may be sufficient.

Overholt has performed lobectomy upon 19 patients (2 carcinoma, 17 bronchiectasis) with 1 operative fatality, and pneumonectomy upon 11 patients (9 carcinoma, 2 suppuration) with 7 operative recoveries.

In 1933 Graham and Singer (13) stated that there were apparently 6 cases in the literature in which surgical procedures had been carried out, the patients remaining well 1 year or more. Of this group, 2 of the patients were operated upon by Sauerbruch, 1 by Churchill, 2 by Tudor Edwards, and 1 by Allen and Smith. Only limited portions of lung tissue had been removed. Graham and Singer reported 1 case which they described as being the first case in which the entire lung had been successfully removed at one stage.

In selected cases it is quite possible that the treatment of primary carcinoma of the bronchus through the bronchoscope with a combination of surgical diathermy and radon seeds may prove of value. Surgical diathermy in the treatment of carcinoma of the bronchus and trachea has been described by Kernan, Figi, Vinson and Bowing, Moersch and Bowing, and others.

PROGNOSIS

It is generally agreed that irradiation therapy will produce a palliative effect, such as reduction of cough, lessening of pulmonary infections about the tumor, and general clinical improvement. The effect is merely palliative and temporary. However, the patient should receive it whenever possible.

Moersch and Bowing, in their cases in which no treatment was given, found the life expectancy after the microscopic examination had been made to be slightly more than 5 months.

Chandler and Potter found that in 59 patients with pulmonary cancer treated by roentgen-ray, the survival was 11 months following treatment. In 61 untreated cases the average duration of life was 6 months.

Vinson and Leddy reported 10 patients, who had received roentgen therapy, living and well from 15 months to 4 years after treatment.

In our series of patients treated by irradiation, 73 received roentgen therapy to the chest or mediastinal region. In 66 of these, it was possible to estimate the duration of life. Others were omitted because of confusing factors, such as coexisting tuberculosis, et cetera. The average duration of life in these 66 treated cases was 15.2 months. In a group of 48 cases in which the duration of life could be ascertained and who received no treatment other than symptomatic, the average duration of life was 8.7 months. One history of particular interest was that of a patient who was admitted to the hospital in June, 1935, with a history of symptoms of 2 years' duration—50 pounds loss of weight, cough, dyspnea, fatigue, and substernal pain. Examination of tissue removed from the left main bronchus revealed adenocarcinoma. He received roentgen therapy in 1935, following which he regained his weight and has been practically symptom free up to the present time. It may be stated, however, that although he is symptom free, except for a slight cough, the tumor has increased somewhat in size as shown by repeated roentgen-ray examinations.

When the technique is perfected for lobectomy and pneumonectomy and more data are available, proper evaluation can then be placed upon these procedures. Probably the only way a complete cure can be obtained will be by one of these methods of surgery. Since so many of the cases are far advanced when seen, roentgen therapy offers a great deal to these patients in making their final days less burdensome and in many instances placing the patient in a more advantageous position socially and economically for a number of months.

SUMMARY

This report is based upon an analysis of the clinical and pathological findings presented by 164 patients having primary carcinoma of the bronchus in whom the diagnosis was established by postmortem examination (100 cases), by histological examination of tissue removed through the bronchoscope (21 cases), by other biopsy examinations (13 cases), or by clinical and roentgen ray evidence (30 cases). In each instance, the end result is known, constituting a 100 per cent follow-up. This is the largest single series of cases to be reported.

There has been an increase in the incidence of primary carcinoma of the bronchus at this hospital. In 1931 the percentage of carcinomas of the bronchus as compared with all admissions made for carcinomas was 1.7; in 1936 the percentage was 6.5. It is quite possible that the increase is the result of improved methods of diagnosis rather than an actual increase in the incidence of the disease.

With regard to treatment, some surgical procedure will probably be the only means by which

a cure may be obtained. Since most of the cases generally seen are far advanced upon admission, irradiation is frequently the only choice. Irradiation therapy will cause a reduction of cough, lessening of pulmonary infections about the tumor, and general clinical improvement with prolongation of life.

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SKELETAL DISTRACTION OF THE TIBIA

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IT SEEMS appropriate at the present time to stop and review the results of a procedure which is of foremost interest to the orthopedic profession, yet about which comparatively little has been written. On reviewing an early report of 2 cases published in 1931, the author finds his work to have been quite incomplete and the great changes that have occurred in technique of operation, construction of apparatus and methods for avoiding complications have impressed him with the necessity of a frank review. The history of leg lengthening has been described but will bear a short summation together with additional reference to the work of a French surgeon hitherto unnoted.

Codivilla in 1905 advocated skeletal traction, the first step forward in this work, but failed to note that the stress of force must not cross a joint and that it must be gradually applied over a period of time.

Beginning in 1908, Magnuson amplified previous work. Attempts to lengthen the tibia by skin traction have been tried and discarded as late as 1918. Putti in 1912 advocated direct skeletal traction on either end of the divided bone, which is the principle I have called distraction, without the passage of the pins completely through the extremity. Other workers have had difficulty in preventing pins in the apparatus from slipping. Abbott of St. Louis in 1927, passed the distracting pins completely through the extremity, obviating the danger invited by Putti's method. Numerous other methods have been devised and descriptions of some of them published but all of those successfully used have embodied the principles of distraction, transfixation of pins, and gradual lengthening.

Following publication of preliminary work with skeletal distraction in 1931, I received a communication from Dr. O. Lambret, of Lille, France, in which he referred to a presentation in 1911 before the Society of Surgery of Paris, published in the *Presse Médicale* in July of that year, which embraced the principles of distraction and transfixation. Included was a two pin apparatus for use on fracture cases. In 1916 this was again published in *Grand Traité de Chirurgie* together with illustrations of the apparatus and roentgenograms of cases. Priority for the first application of real skeletal distraction plus transfixation must, therefore, go to Dr. Lambret who used it in fractures only. Its development in actual lengthening of an extremity has occurred since that time.

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The principles involved in successful lengthening of a bone of an extremity are: (1), skeletal distraction requiring the application of positive skeletal tractive force to either end of a divided bone without the interposition of a joint; (2), complete transfixation of pins with lengthening force applied on both ends of the pins; (3), gradual lengthening over a period of time; (4), maintenance of skeletal distraction for a sufficient period of time following lengthening for solid union to occur.

Apparatus. As late as 1929, a single pin in the upper tibia and in the lower tibia was being used, together with a supporting splint or frame to maintain balance of the foot and lower fragment. Difficulty of maintaining alinement and development of a pressure sore over the os calcis on an early case forced me to the use of an additional pin through the os calcis, allowing direct skeletal control of the foot and lower fragment. Even then, sufficient control of alinement was not easily maintained so that in 1930, five pins in all were being used, two in the upper tibial fragment, two in the lower tibial fragment, and a free pin through the os calcis. In addition, a drill guide was devised for placing these pins accurately in alinement and in 1934, additional sleeves were made for the guide for the placement of Kirschner wires. Since that time, wire has been used in children and pins have been employed in older youths and young adults. Apparatus showing the use of both wires and pins is appended (Fig. 1). The apparatus consists of two side bars with ratchet, operated by keys, a drill guide and pins or wires. When set up, the side bars are placed upon the ends of the four wires or pins, extending through the extremity, and locked to them by set screws. When locked to the pins in this way, there is absolute rigidity and in the case of Kirschner wire, the same rigidity is present as soon as the spreaders have been tautened on the wires. The spreaders themselves act as a suspending apparatus whereby the extremity can be slung to a Balkan frame. When pins are used, the four corners of the apparatus are connected

by wire loops to a single supporting wire for overhead suspension. The pin or wire through the os calcis provides not only for support of the foot but maintains dorsiflexion thereof. The supporting cable for the os calcis pin is kept fastened at an angle toward the head end of the Balkan frame, a padded rest being placed between the metatarsal area of the foot and the supporting cables or Kirschner spreader. The side arms are provided with holes at one-half inch intervals for a sufficient portion of their length so that they will accurately fit onto wires or pins drilled through the guide and any length of tibia can be accommodated. Lateral or anteroposterior angulation of fragments is under the complete control of the surgeon. Lateral angulation can be secured or corrected by rolling out either side arm separately (Fig. 2). Lateral displacement can be overcome by sliding either fragment sideways on the pins or wires and anteroposterior angulation can be secured or corrected in either fragment by the use of levers placed between the proximal or distal wires and drawn down and fastened to the side arms. All these corrections of displacement have been easily and safely overcome in actual cases by the means given without anesthesia and during the actual process of lengthening.

Operative procedure has changed in the last 7 years, both as regards the main procedures and as to mechanical details developed to prevent complications. If followed through carefully, though quite extensive, it progresses rapidly and smoothly. A tourniquet is always used. It is perhaps best to tabulate the procedures.

1. *Incision.* Achilles tendon lengthening is done by inverted "L" incision to maintain continuity of tendon tissue. If further dorsiflexion of the foot is needed, the deep layer of the crural fascia underneath is divided vertically. Posterior capsulotomy of the ankle itself has not been necessary.

2. *Insertion of pins.* Four pins or wires are inserted through the tibia by means of a drill guide. Inserting these pins, two should go through the upper metaphysis and two through the lower, the pins being separated 1 inch. The skin should be retracted as firmly as possible toward the center of the leg to allow for stretching required during later lengthening (Fig. 3). As the skin has been thus retracted toward the center of the leg, the drill guide is placed firmly against the skin with the templet of the guide parallel with the sagittal plane of the tibia and not with the leg. The guides themselves should be pushed through the templet until they are in contact with the skin. Pressure then applied will mark the skin at the point of contact with the guides. Tiny stab incisions can be made through the skin at the marks left by the guides. It is well to note that the guide should be always held on the inner and not the outer side of the leg. The guide is again placed on the leg with the skin retracted toward its center, and a drill hole is placed through the lower guide. A pin placed through this guide and hole can be forced through the anterior muscle bundle of the leg and a nick in the skin is made over the end of the pin thus allowing it to emerge externally. When this pin is in place, the apparatus will be well stabilized for setting the other pins. The second of the distal pins can be placed in similar fashion. It is extremely important when placing the third pin of the series which is next to the top, that the drill guide be sprung forward one-fourth inch on the lower two pins before the hole is drilled (Fig. 4). This third hole is drilled but no pin placed through it until after the fourth pin has been drilled for, put in position, and the drill guide removed. Then the third pin can be driven into place and the fifth pin placed through the os calcis. In the use of Kirschner wire, the same procedure is followed, the wires being introduced directly without drill holes. The reason for the offset third pin is to provide for forcible maintenance of contact of the tibial fragments following osteotomy, thus preventing anterior bowing. Dressings wrung out of Dakin's solution can be placed over the ends of the pins before the next step is taken.

3. *Osteotomy of the tibia.* Through an anteromedial incision, the tibial shaft is exposed in the central area and by motor saw, its cortex is cut through near the internal border and on the lateral surface. These saw cuts are joined below by a transverse cut in front and above by means of the Gigli saw behind. This leaves a tongue above and groove below with the tibia slanted slightly on the pins so that lengthening causes increased forceful apposition of fragments. The fibula is easily reached intramuscularly through the lateral tibial periosteum and divided by osteotome. Whether single or double osteotomy was done (Fig. 7) has seemed to make no difference in the lengthening result, and the level of the osteotomy (Fig. 9) is unimportant. Through the same incision, division of the leg fascias can be done but in none of the cases subsequently reported has it been done. In view of results it seems unnecessary.

4. *Placement of side arms.* The side arms of the apparatus can now be placed on the four tibial pins and extended to tautness by the keys. By sliding the lower tibial fragment, lateral displacement can be overcome (Fig. 2d). If slight

lateral angulation is present, further extension of one side arm will overcome it (Fig. 2c). Anteroposterior displacement is impossible and the fragments will be found very firmly held in apposition due to the offset third pin described. When perfect alinement has been secured, one can proceed with the closure.

5. Wound closure. Wound closure should be with interrupted silk, Stewart, or submarine suture and should include merely the skin and half the fatty subcutaneous tissue. Not only is it not necessary to close the periosteal layer, but it will be found to be impossible to do so. No deep sutures should be used.

6. Dressings. Dressings wrung out in Dakin's solution should be very lightly put in place, not forgetting to dress the tendo achillis incision as well as that of the osteotomy. The pin dressings have already been applied.

7. Suspension of apparatus. The patient is returned to bed and the apparatus suspended from an overhead frame. At first counterbalancing weights were used but it has been found that the patients are more comfortable and the apparatus more stable with fixed suspension, all support being through wires permanently fastened to the overhead frame at a definite level without pulleys or counterweights. A sling of muslin fastened to the side arm may be placed under the calf to give a sensation of support and relieve tension on the suture line. This support should not be too great or it will cause anterior bowing of the fragments (Fig. 5).

8. Suture removal. Removal of sutures should be done on the seventh day, great care being taken to remove the dressing only over the suture area of the tibia and tendo achillis without disturbing the dressings covering the emergence of the pins from the leg. This is generally easy to accomplish since the dressings were placed on the pins before actual lengthening operation on the tibia was begun.

9. Lengthening process. Lengthening should not be begun until 2 or 3 days after removal of sutures when all dressings are off and the actual incisions and the whole leg and foot are open to inspection, except the emergence of pin holes. If any complication such as hematoma or infection develops during the course of lengthening, no further attempt to secure extension should be made until the hematoma has been evacuated and healed or other complication has been overcome. In the usual case, incision healing will be present by 7 days, suture holes healed by the ninth or tenth day, and lengthening can safely proceed thereafter at the rate of one-tenth of an inch every other day or slightly faster. In children, union will be occurring by the time lengthening is secured, but in adolescents and adults, no fear of union occurring to stop lengthening need arise. In fact, it is delayed in adolescents and fails to occur without additional bone graft in adults. Plenty of time is allowed, therefore, in these latter cases for overcoming complications and still securing lengthening.

10. Fixation. When the desired or maximum amount of lengthening has been secured, the apparatus and limb are removed from suspension. The dressing on one side of the os calcis pin is pulled off the pin, iodine and alcohol applied at the point of passage through the skin and the pin is cut off with sterile rivet shears at a point which lies beneath the dressing and has remained sterile throughout the lengthening. The remainder of the pin can be pulled through the os calcis and iodine injected through the pinhole without anesthesia or pain to the patient. The pinholes are uniformly without sensory nerve supply. Dressings are placed over the os calcis pinholes. A plaster cast is applied inside the side arms firmly incorporating the tibial pins and their dressings in plaster. Following hardening of the cast, the pins are cut between the cast and side arms with rivet shears, and the ends of the pins remaining are covered with another layer of plaster bandage. When wires are used, clips on the wire ends are included in the cast to prevent the wires from bowing. The plaster boot should extend up the thigh to give a sense of stability to the patient. The cast can be cut and wedged to get perfect alinement, and reinforced at the cut with a few layers of plaster to maintain correction. Actual contact of fragments is positively maintained by the four pins remaining in the tibia. The patient can now become ambulatory on crutches.

11. Osteoplasty. Osteoplasty of the upper defect is generally required if the patient is over 12 years of age and always required if the patient is an adult. Graft of the lower defect has not proved necessary due to the large mass of shaft left there at time of operation (Fig. 7). By the time lengthening is complete, roentgenograms will give a definite knowledge as to whether bone graft to fill the upper defect in the tibia behind the tongue is necessary. There are several reasons for having the tongue cut above, but the most important is that it places the defect which is largest toward the upper part of the tibia where osteogenesis is best. If osteogenesis has failed to progress by the time lengthening is complete, there is no reason for delay in grafting this upper defect. It can be done within a week of the appli-

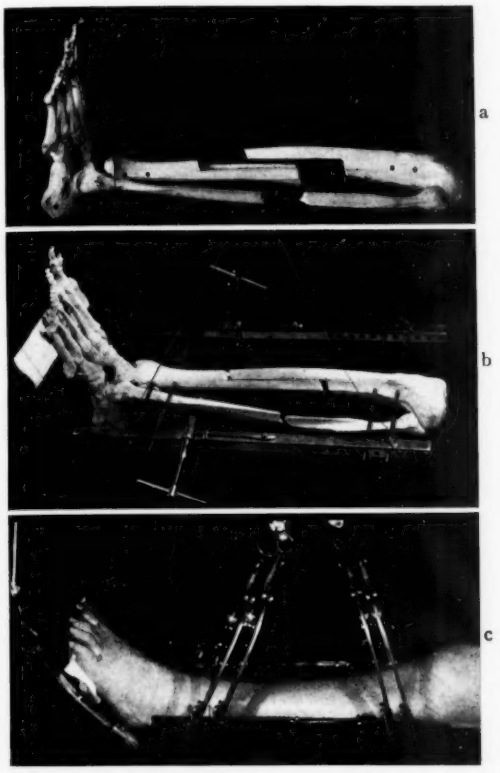


Fig. 1. Lengthening apparatus as applied with three-sixteenths inch drill steel pins and Kirschner wires. Note fifth pin through the os calcis and support of padded bar under metatarsals. Tongue and groove osteotomy of the tibia shown, leaving larger portion of tibia below which regeneration is slower. Single osteotomy of fibula present. The offset position of the third pin hole causing forced apposition of fragments can be seen. Note distance of pin holes from joint surfaces and osteotomy site. Plenty of room left for dressing and exposing osteotomy wound without changing pin dressings or exposing points of pin entrance.

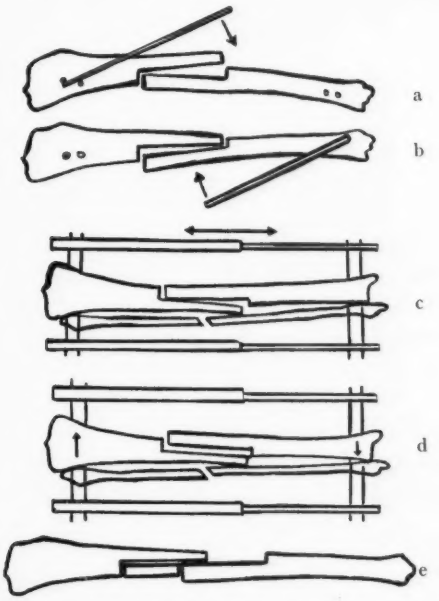


Fig. 2. a and b, Diagrammatic sketch to show method of correcting anterior or posterior angulation by use of levers placed between the upper and lower wires. The action of the lever in a is the same as that caused by the offset third pin at time of operation. c, Correction of lateral angulation by lengthening of one sidearm. When wires are used they go through the distal fibula. When pins are used they are placed anterior to it. d, Method of correcting lateral displacement by sliding fragments sideways on wires. e, Strips of cortex (represented as a block) have been removed from the other tibia and inserted behind the tongue in the upper defect, thus preventing loss of length and hastening osteogenesis by acting as grafts. This must be used on adults.

cation of the supporting cast through a window in the cast, bone being taken from the other tibia. Strips of bone are inserted in the defect abutting the lengthened fragment ends, thus preventing telescoping and loss of length. Following placement of the graft, the cast is closed again and remains in place without further disturbance until solid union has occurred.

APPLICATION OF PROCEDURE

Twenty-four tibial lengthenings have been completed in the past 8 years (Table I). These have been separated into three classes for study, as they vary considerably regarding the ease of lengthening and period required for the end-result secured. Six of the cases have had shortening following poliomyelitis, 13 were short normal legs, and 5 were recent fractures. By short normal legs I mean legs in which there was no pathological condition except for the shortening itself and no muscular paralysis. They include 4 cases of malunion of fracture of many months' duration, 1 due to tuberculosis of the hip, 1 due to shortening of the thigh from osteitis fibrosa cystica of the femur, 2 following early closure of the epiphyseal lines of the tibia following injury, 2 resulting from old congenital dislocation of the hip, and 3 due to dyschondroplasia. These three lengthenings for dyschondroplasia occurred in 2 patients, 1 of whose legs was lengthened and later reoperated

Fig. 3. The skin is retracted toward the center of the leg to allow for the stretching it will receive as the leg is lengthened. The second pin has been drilled through to the skin and the skin is being stretched over the end toward the center of the leg before it is nicked by the scalpel for passage of the pin.

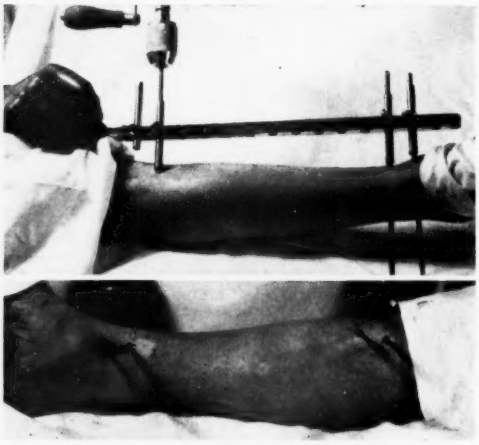


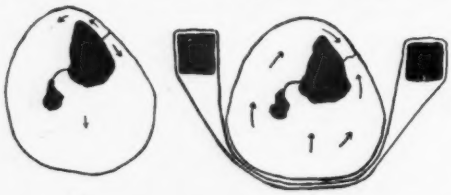
Fig. 4. Above, the drill guide is shown being sprung forward for the placing of the offset third pin. This will cause forcible apposition of fragments later. Pins or wires are spaced at one inch intervals. Below, all five pins are in place. Note the offset third pin from the bottom in the tibia which maintains forcible contact of tongue with groove and prevents anterior bowing.

on and lengthened further. She was a chondrodystrophic dwarf with a very short femur and a total of 3½ inches was secured by the two lengthenings. The other had a dyschondroplasia of the whole lower extremity, evenly balanced between the tibia and femur. The third classification of cases was recent fractures and of these there were 5. All were seen within 1 to 4 weeks following fracture and were easily lengthened and length maintained.

Five of the 24 cases have been done too recently to report (within the last 18 months), so that 19 remain for study. Of the cases indicated for study, the most recent was done 28 months ago and the first, 8½ years ago.

Gain in length. (Table II). The greatest gain in length secured by one operation was 3½ inches in a case of poliomyelitis (Fig. 9) the least, 1¼ inches. In every case, the gain secured was the total amount required to balance the patient. Children were measured every 3 months for 9 months to 1 year to estimate the rate of shortening.

Lengthening was then planned to care for the estimated amount of shortening at time of cessation of epiphyseal growth. No child below 8 years of age was or should be operated upon. Younger than this we could not satisfactorily estimate the rate of growth. All the adult patients were examined before operation, placing a raised shoe or block under the foot, and their gait and posture noted to determine accurately the amount of lengthening which would be optimal (Fig. 6). Frequently, a complete lengthening to match the good leg would not have given a good general correction to their posture as fixed



a b

Fig. 5. a, The result of suspension of the leg by pins is a thinning of the scar due to pull on the tissues over the tibia by the sagging calf. b, Support of the calf in a sling passed over the side arms releases the pull on the suture line resulting in quicker healing both of the skin incision and of the bony structures with a thicker pad of soft tissues over the tibia at completion of the case.

TABLE I.—DISTRIBUTION OF CASES

	Cases
Poliomyelitis	6
Short normal	13
Malunion fracture	4
Tuberculosis of hip	1
Osteitis fibrosa cystica femur	1
Early closure epiphysis	2
Dislocation of hip	2
Dyschondroplasia	3
Acute fracture	5
Total number tibial lengthenings	24

TABLE II.—SUMMARY OF CASES

	Case No.	Gain inches	Speed inches per diem	Stat gain inches	Pain days post-operative	Pins out months post-operative	Follow-up years post-operative	Complicating factors
Acute fractures	1	2				x	x	Fractured rib; empyema perforated lung; died
	2	1½	Immediate	Full	Relieved	2	6½	Graft
	3	1½				1½	3¾	Compound
	4	1½				2	6	Graft
	5	1¼				1½	3	None
Suppurative knee	6	2¼	1/16	¼	4	3	7½	Graft
Fracture	7	2	1/32	3/8	1	2	8½	Graft
Fracture	8	1½	1½	1½	1	1½	4	Old age
Chondroplasia	9	1¾	3/32	3/8	2	1½	6	Infected
Poliomyelitis	10	3½	1/16	¼	2	3	4	Delayed union
Fracture	11	2	2	2	1	1½	6½	None
Poliomyelitis	12	1¾	1/16	¼	4	4	5½	None
Poliomyelitis	13	2	1/16	¼	5	1½	6½	Graft
Closed epiphysis	14	2½	1/16	¼	4	4	5½	None
Poliomyelitis	15	1½	¼	¼	10	4½	6½	Infected
Suppurative hip	16	2½	1/8	1/10	16	5	5½	Infected
Poliomyelitis	17	2	1/16	1/8	31	16	4½	Delayed union
Tuberculosis of hip	18	2	1/16	¼	2	3	3½	None
Fracture	19	1½	1½	1½	2	2	5½	None

changes had already taken place in the spine and pelvis to accommodate some of the shortening present in the leg. For this reason, adult short legs were not always lengthened to match the long leg but merely enough to give them the best possible stance and gait as determined before operation. In all cases but 1, the desired amount of lengthening was secured. This case was the chondrodystrophic dwarf in whom it took two separate lengthenings, 3½ years apart, to overcome enough of the shortening to give her a fair stance and gait. In none of the cases did the lengthening secured prove too much and throw the patient out of balance. The speed of lengthening is also shown in Table II but certain points which are very important might not easily be seen. The recent fractures permitted immediate attainment of full

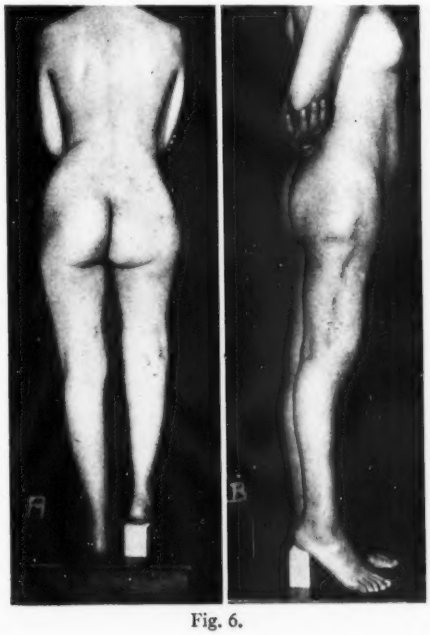


Fig. 6.

Fig. 6. a, The block used here is not enough to compensate for full amount of shortening. Fixed spine and pelvic changes were present which made this raise of the leg comfortable and helpful. Full correction by a longer block caused the patient's trunk to shift to the left and gave her a severe posture defect. b, This patient has perfect balance resulting from full correction of shortening by a block under heel before operation, proof that fixed spine and pelvic changes do not contra-indicate full lengthening of the short extremity in this case.

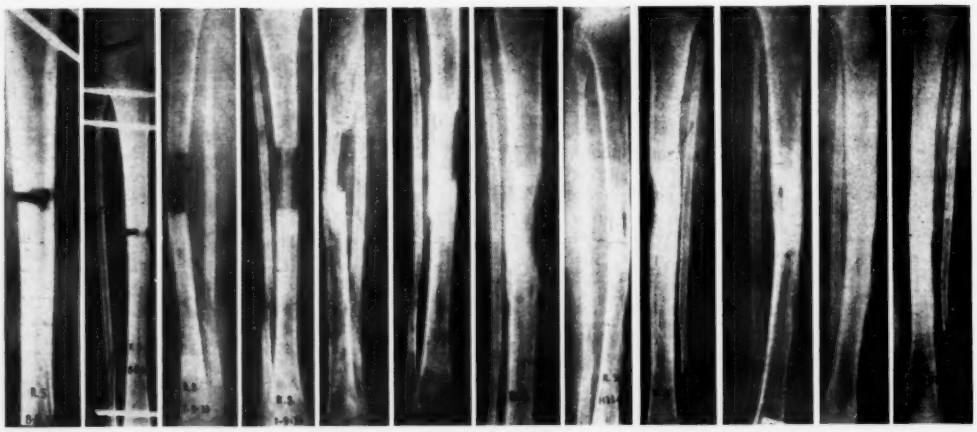


Fig. 7. Young adult, 5½ year result. Double osteotomy of fibula used. Upper site healed and all lengthening was gained through lower. Single osteotomy of fibula preferable. Grafting of tibial defect done both by onlay and interposed bone. Pin holes show complete closure. Placing pins further posteriorly would have prevented slight amount of anterior bowing, and this could have been removed by wedging the post-lengthening cast. Note small amount of immediate gain in lengthening at the time of operation.

reposition (Fig. 10). Three of the four malunion fractures, though solidly united and many months old, permitted full gain of length within an hour on the operating table; one of them 2 inches (Fig. 11) and 2 others, 1½ inches each. The fourth malunion fracture, though only 5 months old, was only lengthened a twelfth of an inch a day.[1] All the other short normal legs were lengthened over a period of time. It will be noted that in 2 of them which were lengthened too rapidly (at the rate of one-fourth and one-sixth inch a day, respectively) the incisions broke down.

[1]From Skeletal distraction, description of apparatus. David M. Bosworth. Surg., Gynec. & Obst., 1931, 52: 893–897.

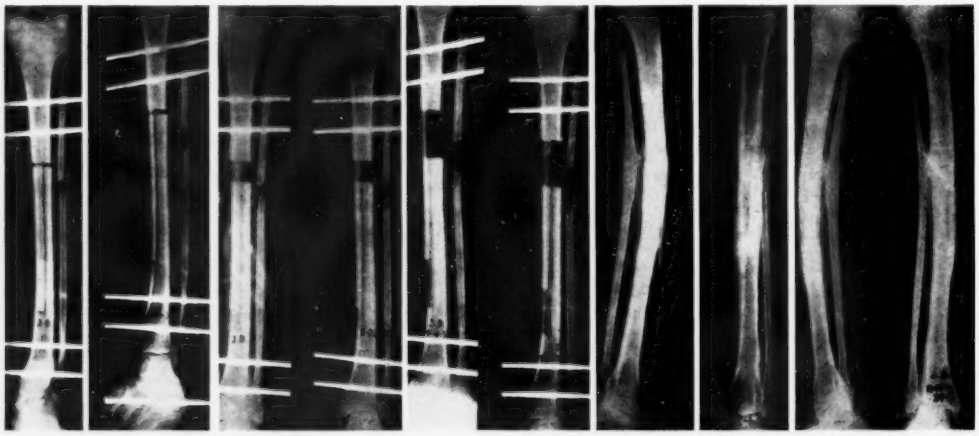


Fig. 8. Young adult, poliomyelitis, 6½ year result. High osteotomy of fibula present (Fig. 7). Excellent alinement through lengthening with final bowing due to not holding in plaster long enough for complete ossification of defect to prevent pull of calf from bending soft plastic area in tibia. Pin holes healed. Slight eversion of ankle by x-ray in last picture not clinically appreciable. Bowing much less pronounced physically than by x-ray. Note small amount of immediate gain in lengthening at the time of operation.

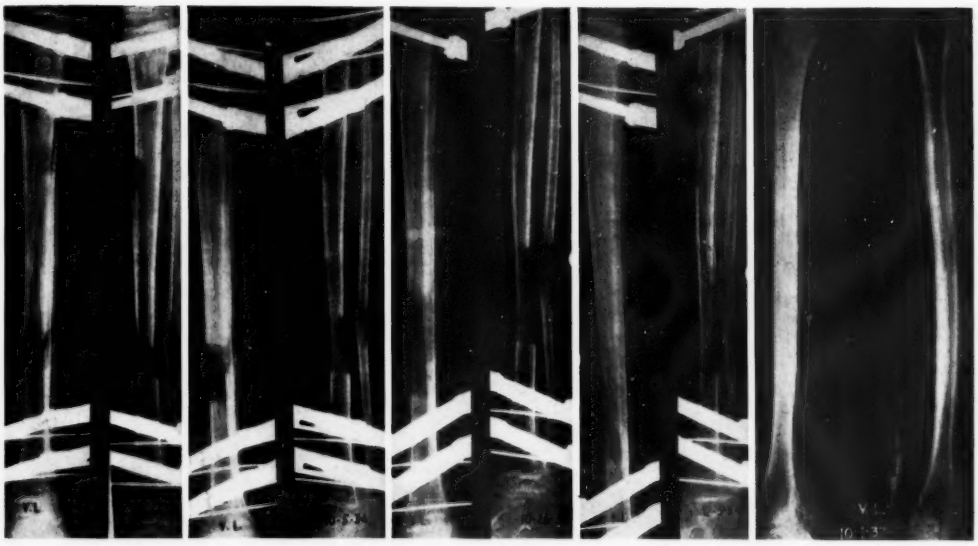


Fig. 9. Adolescent poliomyelitis, 3 year result. Lengthening of 3½ inches completed in 14 months. Lumbar sympathetic ganglionectomy to increase blood supply of blue paralytic leg, subtalar arthrodesis, posterior ankle block and knee fusion all preceded lengthening. Note angulation corrected at time of cast application. Pin holes healed, single fibular osteotomy, reformed marrow cavity. Rather marked ankle eversion not appreciable clinically.

Only one other infection in the series occurred and this was due to the use of deep sutures and vaseline gauze dressing. All three healed, united, and maintained the length gained. They have shown no recurrence of infection during the past 4 years. An average speed of one-tenth of an inch a day during the complete postoperative period of lengthening is within safe limits and a greater speed is dangerous. The immediate gain in lengthening at time of operation, except in fractures, is about one-fourth of an inch, and it is not possible to secure more than three-eighths of an inch in short normal legs or poliomyelitic legs, even with very forcible extension of the apparatus (Fig. 8).

Postoperative pain has been considered a reason for avoiding leg lengthening, but as can be seen from Table II, it was not persistent except in 3 cases. Two of these 3 cases were the ones in which lengthening was started immediately after operation without waiting for wound healing, and continued at too rapid a rate, namely more than one-sixth of an inch a day. The third case was a young woman who complained continuously, until after application of her cast following completion of the lengthening. The length of follow-up on all cases is included in the same table for convenience.

Numerous questions have arisen regarding the pins placed through the tibia and some of these questions can now be definitely answered. In 1 case, the pins remained in position without infection or change of dressing for 16 months. They were still tight at the end of that time. The average length of maintenance *in situ* was between 3 and 5 months. In 16 of the 19 cases the pins were still firmly in place at time of removal, and without apparent bony absorption surrounding them. In only 3 of the cases was there infection of pinholes. These 3 cases included the two which were run out too rapidly, and the one in which the wound broke down due to deep sutures. In all other cases, pinholes were dry and without discharge. All pinholes healed within 3 weeks except in 2 of the infected cases mentioned. One of these required 3 months and the other 4½ months to heal. The holes in the tibia caused by the pins filled in completely in 8 cases, almost completely in 2 others, and partially in 1 other. In all remaining cases the hole which persisted became surrounded with cortical bone with rearrangement of the internal structure to assume new lines of force (Fig. 12). In 1 of the cases lengthening was too rapid and a sequestrum formed which was easily removed; healing took place subsequently and left a leg with full regeneration of the tibia

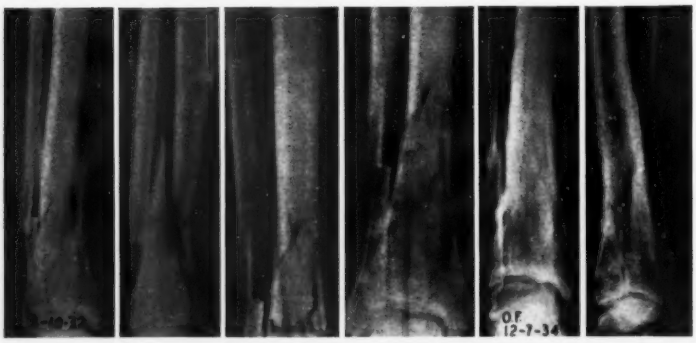


Fig. 10. Comminuted acute fracture reduced with leg lengthening apparatus, closed method, and placed in immediate cast including the pins.

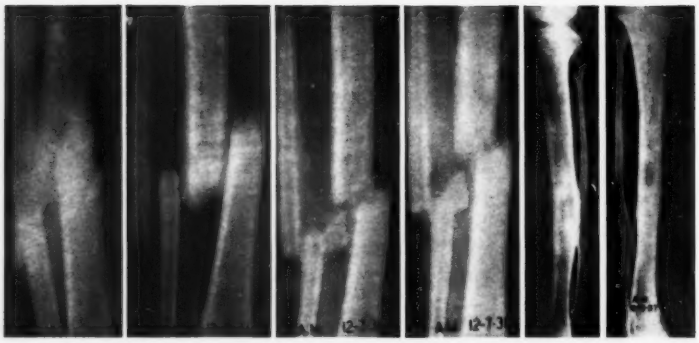


Fig. 11. Young adult, 6 year result. Malunion fracture of 6 months' duration reduced in 1 hour with apparatus, (open operation) wide stripping of the periosteum, osteotomy of callus area, great extensive force and manipulation of fragments and soft tissue with distractive force acting. Note pin holes still not completely closed.

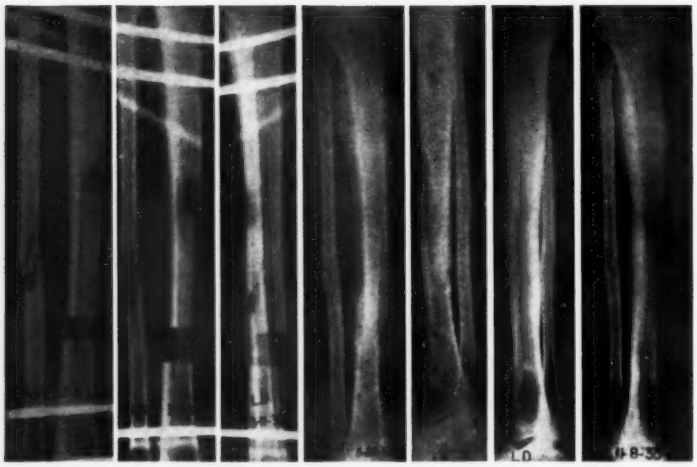


Fig. 12. Necrosis of the wound resulted in this case from the use of deep sutures and vaseline dressing. One and one half inch gain maintained. Healing of skin and bone defect was rapid and the same leg was lengthened another 2 inches within the past year without complication. Note cortical bone formation about lower pin hole and realined lines of force in surrounding bone.

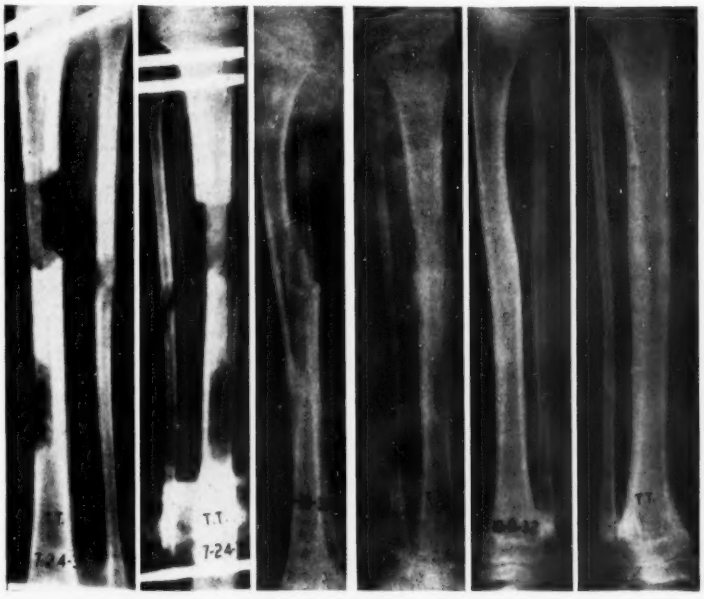


Fig. 13. Following union of lengthening, this boy's tibia grew 6 inches in length in 4 years. Note that slight posterior bowing results in no defect. This is definite proof that operative lengthening does not stop epiphyseal growth.

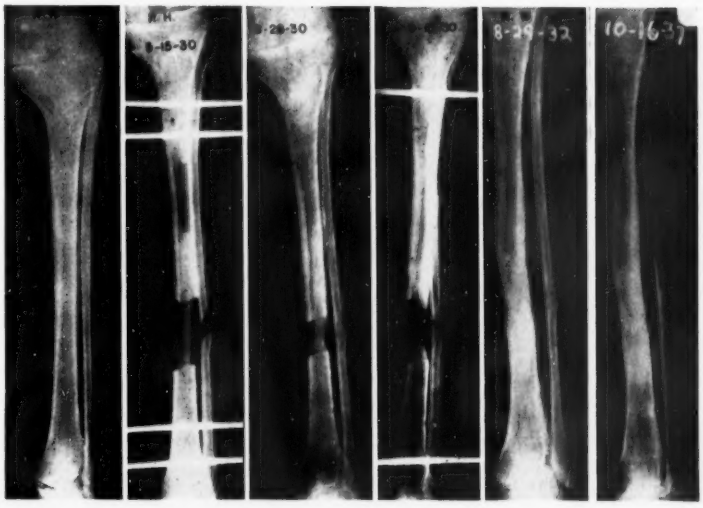


Fig. 14. Young adult, 7½ year result. Shortening due to suppurative arthritis of the knee at 1 year of age. This shows result of placing the tongue of the lengthening below. Delayed regeneration, fracture and absorption occurred. Successful relengthening to 2 inches and defect grafted.

and the original amount of length secured. Four cases required grafting following the lengthening; 3 in old malunion fractures, and 1 a young woman of 18 years with a short normal tibia (Fig. 14). Growth of the legs continued in every case in which the patient was in the growing period. One child's tibia grew 6 inches in 4 years following complete union of the lengthening (Fig. 13). No epiphyseal cartilage damage could be demonstrated in any instance. There was definite clinical evidence of damage to joint structures as follows: 6 ankles showed a loss of motion varying from

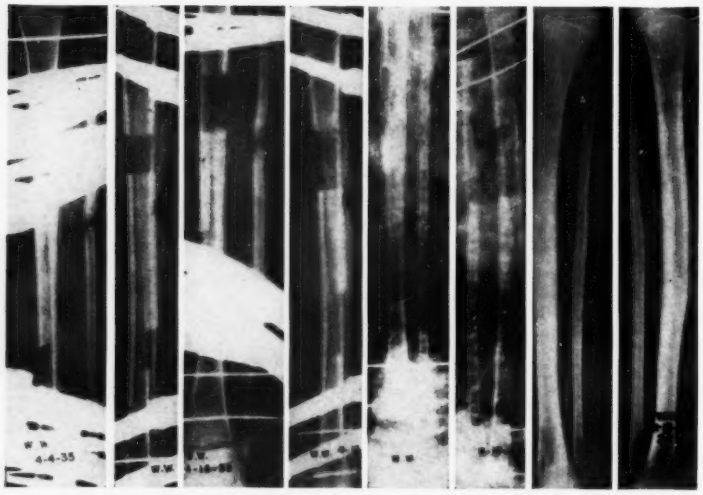


Fig. 15. Two and one-half year result in adolescent with shortening due to tuberculous hip. Slight bowing which occurred after removal of plaster due to the pull of the calf on soft bone at the site of lengthening. Note that the wires went through the distal fibula as well as tibia, resulting in drawing the fibular head to a lower position than normal. No clinical embarrassment from this.

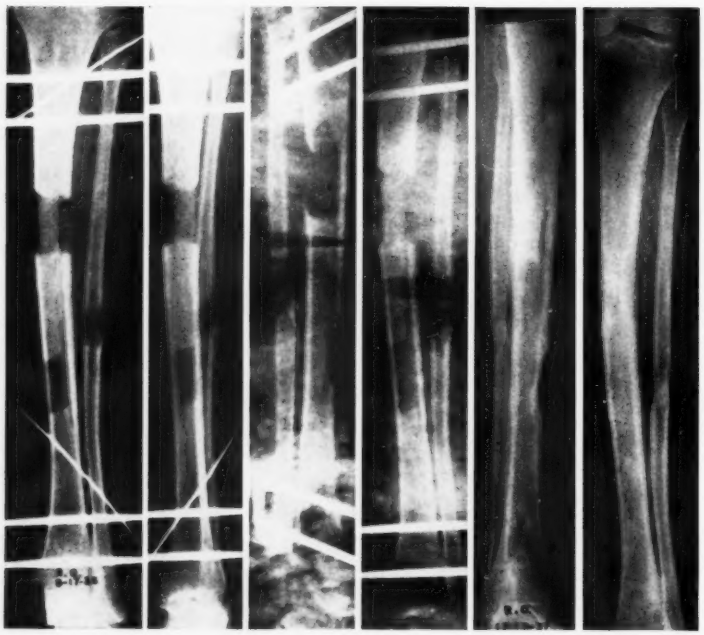


Fig. 16. R. O., 30 year old female; lengthening of 1 7/8 inches, completely solid; walking in 7 months. Speed of recovery due to immediate graft of upper tibial defect following lengthening. Shelf operation for congenital dislocation of hip preceded lengthening and subastragaloid arthrodesis for associated foot deformities followed immediately after lengthening to complete the case.

one-tenth to one-fourth. Two knees showed a loss of one-eighth, and one-third, the range of normal flexion respectively. No relaxation of joints could be demonstrated due to this procedure. There were no cases of shock and no deaths. It was found that the length of time required for union was shorter when the tongue of the tibial osteotomy on the upper fragment was made fairly large. The fascia of the leg was not divided in any case. No complication or difficulty

TABLE III.—DISABILITY

	Total Weeks	Partial Months	Retarding Factors
Poliomyelitis			
4 uncomplicated	6–12	4–16	Age—length gained
1 complicated	12	33	Infection
Short normals			
4 uncomplicated	2–12	5–15	Age
5 complicated	6–8	4–26	Bone graft—Infection
Acute fractures			
2 simple	1	4–8	Comminution
3 compound	1	4–15	Infection—Nonunion

TABLE IV.—COMPLICATIONS OF LENGTHENING

Complication	Number	Causal factors
Infections	3	Too rapid lengthening, catgut sutures, locked stitch, vaseline dressing, deep sutures used
Slow re-ossification	3	Age of patient, length gained
Bone graft required	4	Age of patient, compound fracture, comminuted fracture, failure of continuity
Anterior bowing	5	Early cast removal, third pin not offset, first cast not wedged
Ankle eversion	6	Early fibular union, incomplete osteotomy fibula
Hematoma	2	Unknown

in lengthening due to intact fascia was noted. A drain was used on one of the early cases, but it is believed better to take the risk of an occasional hematoma. The optimal dressing is one wrung out of Dakin's solution and was found to leave a cleaner incision than either dry or vaseline gauze.

The period of disability is shown in Table III. The greatest factor extending disability, appears to be the age of the patient. Children unite very fast and can be completely ambulatory in 4 to 7 months. Adults require 12 to 16 months. One infected case required 33 months. A safe average would be a year. Infection delayed the end-result in each of 3 cases tremendously.

Complications are shown in Table IV. There was infection in 3 cases, 2 following rapid lengthening and 1 from use of deep sutures and macerations by vaseline gauze dressing. I believe that they can be avoided by slow lengthening; the use of silk sutures; avoidance of locked stitch, deep sutures, and drains; and the use of a dressing wrung out in Dakin's solution. Delayed reossification occurred three times, and in each instance was directly attributable to the age of the patient, the length of the gap left in the tibia or the small size of the upper tibial tongue (Fig. 8). Nonunion which required grafting occurred four times and was the result of compounding or comminution of previous fracture, failure of sufficient continuity of bone contact, or age of patient. All were grafted successfully. Anterior bowing occurred 5 times in the early cases of the series. It has not occurred since the offset third pin has been used and the cast wedged, nor has it been enough to embarrass the operator or patient. It rarely occurred during lengthening but generally afterward when skeletal traction had been removed, and the pull of the muscles bowed the soft new bone (Fig. 15). Moderate eversion of the foot at the ankle occurred 6 times. In only 1 case was it of sufficient extent either to come to the patient's attention or to require correction. In that case a later osteotomy of the tibia and fibula corrected the deformity. In 2 instances the eversion was spontaneously corrected by epiphyseal growth in less than 3 years. Hematomas have occurred twice, and in each instance have been evacuated successfully without infection and without preventing completion of lengthening. It is imperative to await complete healing of a hematoma. Reoperation is always possible at a later date, provided one has not rashly proceeded with the lengthening and lost the extremity through infection. Cavus foot and hammer toes gradually develop during lengthening, due to tautness of flexor and extensor tendons. In no case did they persist. The muscles gradually stretch after lengthening is complete and the foot and toes straighten out. A new marrow cavity developed in every case, and several times was present as early as 4 to 6 months after operation. There were no cases of footdrop, either temporary or permanent, nor evidence in any case of peroneal or tibial nerve irritation or paralysis. No extremity showed decreased blood supply due to stretching of the blood vessels.

There were 46 other operations performed on these 24 patients not including the lengthening operations and grafts of the lengthened site. Most of these other operations were on poliomyelitis patients. Their reconstruction is always more complicated than the ordinary case. In 2 cases lumbar sympathetic ganglionectomy was done so as to secure sufficient circulation for lengthening. The child who gained 6 inches in length from growth, following tibial lengthening, was not one of these; therefore his growth could not be attributed to that procedure. Other reconstructive operations on poliomyelitic cases included one osteotomy of the tibia and four osteotomies of

the femur for genu valgus, genu varus, or slight knee flexion defects; 7 subtalar arthrodeses; 1 posterior ankle block; 5 tarsal sections; 2 knee fusions; 5 transplantations of the extensor tendons to the dorsum of the foot; and 2 spine fusions for paralytic scoliosis. Besides these, the following reconstructive operations of other non-poliomyelitic cases were necessary prior to lengthening of the tibia. One bone graft was done for non-union fracture. Three operations for congenital dislocation of the hip had been done elsewhere on one patient and a shelf operation was done in our clinic to stabilize the extremity. A tuberculous hip had four attempts at fusion before solid union was secured. Eight skin grafts were performed in 4 traumatic cases before lengthening, to remove adherent scar and cover the tibia. A laminectomy fusion was done in a case of chondrodystrophic dwarf with hemivertebra, angulation of the cord and bladder symptoms.

In concluding, there have been no mortalities, no loss of extremities, no failure to gain or maintain length, no non-union, and no unhealed or disabled cases. To take a series of such cases and carry them through successfully entails strict adherence to detail and technique, and personal attention to every step of the procedure throughout the patient's operation and convalescence.

OPERABILITY IN CANCER OF THE RECTUM

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EVIDENCE of the fact that operability is a more or less vague term is apparent when one reads the literature and finds that operability statistics in cancer of the rectum are at great variance, being quoted from 25 to 70 per cent. Many of these statistics are presented by able surgeons of equal capabilities and the only way the wide difference can be explained is that figures are arrived at by entirely different methods of analyzing groups of cases. It seems to me that a simple method of computing our statistics could be used, so that various series of cases could be compared on an equal basis. With this object in view, a critical analysis of one hundred consecutive cases of cancer of the rectum has been made, listing exactly what happened in each case. For instance, a patient is advised to have an operation and promises to go to the hospital but does not return. Such cases make up a certain percentage of everyone's total series, but the question arises: Where should this case be classified? One writer will not include the case while another will add it in his total. When such cases amount to 10 per cent of the total, it is easy to see that a wide variation in figures will result, but this would not be true if all data were summarized in the same manner. In the table below is listed exactly what happened to one hundred consecutive patients with primary untreated carcinomas of the rectum as they appeared for examination during a period ending July 1, 1937.

TABLE I

A. Patients examined		100
B. Radical operation advised, did not return		10
Balance		90
C. Operation not advised, too far advanced	11	
Palliative procedure advised	9	
		20
D. Operated upon for cure		70
E. Inoperable at exploration		13
Liver involved	10	
Local fixation	3	
F. Operation completed		57

It is evident that 10 patients (B in Table I) whose condition was considered clinically operable did not return for various reasons, viz., distance away from home, objection to colostomy, or desiring another hospital or surgeon; therefore, operability should be computed on a basis of the figure 90. I think this is fair because, if exploration were done, it is quite likely that in at least 8 cases the operation would have been completed, judging from the number of cases with complete operation as shown in the table.

An analysis of the inoperable group of 20 cases (C in Table I) is given in Table II.

TABLE II.—ANALYSIS OF INOPERABLE CASES

No operation was advised in 11 cases because:	Cases
a. Palpable liver metastases	3
b. Extensive local invasion	1
c. Bladder perforation and age	2
d. Fixation in patient aged 71	1
e. Age 75, condition poor	2
f. Cachexia and moribund	1
	11

While I am a staunch advocate of colostomy, there are certain patients for whom it is not indicated and, in this group of 11 patients, I did not think it would add materially to their comfort.

Palliative operations were advised in 9 cases for the following reasons:

	Cases
Advanced lesions, ages over 70, condition poor	5
Fixation and pelvic metastases	4
	9

Palliative operations consisted generally in colostomy with or without radiation and, in some cases, radiation or coagulation without colostomy. The reasons for these procedures varied: (1) obstruction; (2) liver involvement, extreme age, etc.

In these two groups, then, which comprise 20 cases, the condition was considered inoperable; on a basis of 90 cases, that is 22 per cent.

There remains a group of 70 cases which we considered to be clinically operable or at least deserved exploration, even though many were borderline cases from the standpoint of fixation. Based on the figure of 90, this can be construed as an operability figure of 78 per cent. However, it will be seen that the growth in 13 of these 70 patients (D in Table I) was found at exploration to be inoperable due to liver metastases (10 cases) and local fixation (3 cases). In this group of 13 cases, 8 patients had colostomy and 5 did not, because it was estimated that death would

From the Cleveland Clinic.

intervene before obstruction occurred. Therefore, based on the figure of 90, there were 57 completed operations, or 63 per cent, whereas computation on the basis of the 70 explored cases would give an operability figure of 80 per cent. Furthermore, it will be seen that, excluding the cases in which the liver was involved, we completed the operation as far as the local lesion was concerned in 56 of 60 cases, or 90 per cent.

It is apparent then why operability figures vary. For purposes of comparison, therefore, operability figures should be reported both in relation to the number of cases seen and those in which operation is advised and in relation to the cases explored. These figures bear out the fairness of eliminating the 10 patients whose condition was thought to be operable but who did not return because it is quite likely that the same ratio of 80 per cent operability would hold as it did in the group of 70 cases, so that the figures would not be altered.

Of the 57 completed consecutive operations, the type of operation performed is shown in Table III:

TABLE III

	Cases
Combined abdominoperineal, 1 stage	54
Colostomy and posterior resection	1
Colostomy and segmental resection	1
Electrocoagulation (early lesion)	1
Total	57
Mortality in this series	4
Based on 56 major procedures	7.2%

MORTALITY

From Table III it will be seen that 80 of the 100 consecutive cases were considered operable clinically, but 10 patients did not return so that 70 entered the hospital for radical operation. Due to reasons stated previously, operation was incomplete in 13 cases; 8 patients had colostomy only, and 5 did not. There were no deaths in this group. In the 57 remaining cases, 56 major procedures were carried out. Fifty-four of these were combined one-stage procedures, and there were 2 two-stage procedures. The additional case, an early one in which electrocoagulation was done, is not counted as a major procedure and was not calculated in the mortality statistics.

In this group of 56 cases, there were 24 females and 32 males and their ages were as follows:

TABLE IV.—AGES

	Cases
25 to 30 years	1
30 to 40 years	8
40 to 50 years	10
50 to 60 years	16
60 to 65 years	11
65 to 70 years	9
70 to 80 years	1

It will be seen that more than one-third of these patients were between the ages of 60 and 70 years.

In the 56 consecutive cases in which a major operation was performed, 4 deaths occurred, a mortality of 7.2 per cent. Based on the 54 one-stage procedures in which the deaths occurred, it was 7.4 per cent.

The causes of death are shown in Table V.

TABLE V.—CAUSES OF DEATH

	Cases
Peritonitis	2
Pulmonary embolus	1
Bronchopneumonia	1

One case of peritonitis and one of pulmonary embolus were proved at autopsy; the 2 others were clear cut clinical diagnoses (Table VI).

TABLE VI

No.	Sex	Age	Death after operation	Cause of death
1	F	32	12 days	Peritonitis and obstruction (clinical)
2	F	61	19 days	Pulmonary embolus and thrombosis in a patient ready to go home (autopsy)
3	M	51	3 days	Definite pneumonia (clinical)
4	M	65	10 days	Peritonitis; abscess abdominal wall; diffuse cellulitis of the scrotum; diffuse purulent peritonitis (autopsy)

From the standpoint of operability and mortality, it is obvious then that the one-stage procedure compares quite favorably with the multiple stage procedures. For purposes of analysis and comparing operability figures the simple table described previously is suggested.

TRANSVESICAL DIATHERMY IN THE TREATMENT OF CARCINOMA OF THE BLADDER

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CARCINOMA of the bladder, despite the varied technical procedures devised for its management, remains a distinct problem in the field of urological surgery. Success in its treatment, commensurate with knowledge thus far attained in reference to carcinoma in general, lies in early diagnosis and prompt institution of therapy. Centralization of therapeutic data for analysis and statistical appraisal, as embodied in the Tumor Registry of the American Urological Society, will accomplish much in guiding the future therapy of this disease.

The surgical pathology of vesical neoplasia offers a distinct challenge to those who undertake its management, for the bladder must not be considered a single physiological unit but an integral part of the entire urogenital synchronization. Individualization in the selection of treatment is therefore necessary and should be guided by the characteristics of the neoplasm, its location, its size, its relationship to renal function or dysfunction, its extension into and beyond local barriers, and finally, the physical potentialities of the patient himself. Dart, recently, in reviewing 1,224 tumors of the bladder, emphasized that cellular differentiation must be supplemented by the physical characteristics of the growth if one wishes to grade carcinoma.

The multiplicity of the methods of surgical management permit a wide latitude of choice. One of these, transvesical diathermy or electrocoagulation, has received minimal consideration in the medical literature since its clinical elaboration by Corbus in 1921. Recently there have been a few articles reporting favorably on its use (4, 8). Stimulated by these observations, a survey of the case histories of patients treated by this method in the Urological Clinic of the Hospital of the University of Pennsylvania between the years 1923 and 1936 has been made.

CLASSIFICATION OF ELECTROSURGERY

The older method of destroying bladder carcinoma with the Percy cautery and glowing soldering iron met with moderate success. However, because of the rapid evolution of electrophysics and the introduction of refined electrosurgical equipment, these cruder methods have been displaced.

In general, electrosurgery, embodying the principles of the high frequency currents, has a threefold clinical usage: first, the rapid, bloodless, aseptic severance of the normal tissue; second, the excision or destruction of malignant tissue; and third, the coagulation of blood vessels.

The electrosurgical domain is composed of four general groups. (1) "Acusection" refers to the cutting of tissue with the high frequency current. This term is derived from "acusector," an instrument devised by Kelly and so named by him to differentiate the electrosurgical "knife" from the scalpel. (2) "Electrodesiccation" effects destruction by dehydration, the current being of the unipolar Oudin type. (3) "Electrocoagulation" implies a thermic reaction, death of tissue being produced by heat coagulation of the tissues. This current is of the bipolar d'Arsonval type. (4) The term "diathermy" is synonymous with electrocoagulation. The dissimilarity in nomenclature represents a time factor: the longer the application of current, the more extensive the thermal effect in the tissues. Diathermy, therefore, implies a deeper penetration of heat; consequently its destructive effect is greater.

DIATHERMY

The physical limits of diathermy and its effect upon tissue depend on the amount of current generated and its length of application. Radicalism in its application to vesical carcinoma is not warranted, for extensive necrosis and sloughing lead to fistulous communication with contiguous structures—the vagina, rectum, and peritoneum. The cure, if the patient survives, then becomes worse than the disease.

Corbus used 1 ampere of current per application of electrode in his experimental work and postulated as a time limit of sufficient application a blanching and bubbling up of tissue. In 1925, Cunningham, Graves and Bovie clinically introduced the use of thermocouples in the bladder

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wall to control scientifically the thermal effects of diathermy. Heat was recorded from rectum and vagina as an additional means of protection.

Our own technique consists in the setting of the high frequency apparatus so that with each application there is a delivery of 1500 to 2000 milliamperes through a flat disc electrode which measures 1 centimeter in diameter. The amount of time to produce ischemia and bubbling of tissue with the liberation of gases is taken as a criterion of sufficient length of application. This factor will be found to be directly proportional to the size of the electrode employed: the larger the electrode, the longer the period of time to obtain ischemia. A finger in the rectum or vagina is of distinct value in elevating the bladder floor, while epicritic sensation is an additional safeguard against too liberal diathermy.

Current delivered through the active electrode is concentrated in a small area and travels in a perpendicular and radiating direction therefrom. Coagulation is said to occur to a depth approximately equal to the diameter of the electrode, while the immediate peripheral zone is also affected. As the current blends out in the deeper structures coagulation is not produced but the thermal effect is sufficient to interfere with the vitality of cells. Thus there is what can be called an immediate direct and an immediate indirect reaction. Blood and lymphatic vessels are likewise sealed, which is an additional safeguard against local growth and metastasis.

Corbus summarizes his experimental work with diathermy on dogs as follows:

> The immediate effect is a slow "cooking through" of the underlying tissues, the effect upon the deeper structures being the same as that upon the mucosa. This is followed by an aseptic death of the submucosa and muscularis. Round cell infiltration is marked only for the first 3 days. Eventually, the entire area is replaced by a dense proliferation of fibrous tissue, the line of demarcation between the treated area and the surrounding normal tissue being definitely preserved.
>
> The ureteral wall may be "burned back" in the dog almost to the entrance of the intramural portion. The results in 3 dogs under observation for from 3 to 5 months have shown no derangement of function in the ureteral activity or the contractility of the bladder. No obstruction to the ureteral outflow occurred in five months.

It is constantly to be borne in mind that Caulk and Harris showed that this current traveling from the active to the inactive pole followed the channels richest in electrolytes by preference. This means that the urine, the lymph, and the blood channels get the greatest current load, and in these channels the coagulating effect has the greatest penetration and depth.

SELECTION OF TREATMENT

Our premises of therapy do not differ materially from those in many other clinics. Nevertheless, we feel that in attempting to achieve a so called cure, selection of treatment should be individualized and should be sufficiently radical to carry a minimal risk of operative mortality and to promise a convalescence free from excess morbidity.

The most radical procedures, such as total cystectomy, transplantation of the ureters and subtotal resection, while theoretically appealing, become less so in clinical application, because, if success is to be attained, cases must be chosen early when the growth is still small and localized (a clinical exception rather than the rule). In making a decision in this period of the growth's cycle, a less radical procedure is frequently as effective, and one does not always feel justified in subjecting his patient to additional hazards. Bumpus (3), in the discussion of Rathbun's presentation, "Comments on Bladder Carcinoma," has very wisely remarked: "If the chances of cure were equal to the risk involved in these major procedures, they might be more readily justified, but when the mortality rate incident to the treatment considerably exceeds that of the possibility of cure, it seems as though more conservative measures can be justified in many cases."

Tumors occupying the vertex of the bladder are amenable to segmental resection, but by far the greater incidence of malignant involvement is found in the base of the bladder where less enterprising measures have to be adopted. If tumors are small and accessible they warrant transurethral cystoscopic destruction, but we feel that tumors of any magnitude with a cystoscopic index of malignancy and invasiveness should be subjected to transvesical excision and diathermy. In extensive vesical carcinoma, if renal function is still maintained as revealed by urography, if urosepsis has not appeared and in the absence of local or distant metastasis, diathermy is especially applicable. Involvement of a ureteral orifice with a resultant functionless kidney is not a contraindication to the use of diathermy.

If tumors small or large are associated with concomitant pathology in the prostate, such as adenomatous hypertrophy or changes in the vesical neck, necessitating operative intervention, cautery excision and diathermy of the tumor can be carried out in addition without fear of increasing surgical shock.

CLINICAL RESULTS OF DIATHERMIC TREATMENT

Counseller and Braasch in 1935 reported their results in 17 cases of carcinoma considered non-

resectable from the extensive involvement of the base of the bladder. In 5 patients, the ureteral orifices could not be found since they were hidden by the growth or occluded by it. Fourteen patients were treated only with diathermy and 3 had a combination of cautery excision and diathermy. Four cases were graded 4, 5 were graded 3, 4 were graded 2, and 4 were graded 1. Fifteen of these patients, or 88 per cent, lived over 5 years and were free of recurrence. Irradiation or radium was not used as adjuncts in treatment.

Bumpus and Silver analyzed a group of 43 cases treated similarly and deducted that they obtained "approximately a 19 per cent possibility of a 3 to 5 year cure by this method."

The subject of our report is a series of 51 cases treated by transvesical diathermy between November, 1923, and July, 1936. Due to the small number of patients and insufficient time interval of follow-up in a few, they shall be considered under 3 general headings: (1) the dead; (2) the living; (3) the indeterminate.

1. There were 29 deaths in 51 cases, a mortality of 56.8 per cent. Analysis of these confirmed the oft repeated statement that the cause of death in vesical carcinoma is, in most instances, attributable to renal infection and renal failure. There were 27 cases of papillary carcinoma, 1 case of adenocarcinoma, and another case with a large growth classified as a papilloma.

Five of the 29 deaths were classified as operative deaths, a percentage of 9.8 for the entire group of 51 cases. Two of these deaths followed the second transvesical operation for extensive recurrence. The third patient died as a result of poor cardiorenal reserve after combined suprapubic prostatectomy and transvesical diathermy. The fourth and fifth patients lived 9 and 22 days, respectively, after operation, the causative factors of death in each case being marked urogenital sepsis with secondary blood stream invasion.

A sixth patient was known to have died and, despite the fact that no record of survival period or recurrence could be found, was considered in this tabulation.

The 23 remaining cases were grouped into survival periods as follows:

5 survived 1 to 6 months
11 survived 7 to 12 months
3 survived 13 to 18 months
4 survived 24, 32, 34 and 44 months, respectively.

There is insufficient follow-up data in 3 of these 23 cases as to whether or not recurrence was present at the time of death, although the period of survival in each is recorded as 8, 32, and 44 months. In the 20 remaining cases, in which the follow-up data are accurate, recurrence was found in 17 cases and no recurrence in 3.

Further analysis of these 3 cases of non-recurrence disclosed that 1 had had a large basal growth, diagnosed papilloma. This was diathermized transvesically 24 months before a cautery punch operation of the vesical neck was performed, from which the patient succumbed.

The second patient survived 4 months after operation. No recurrence was found in the bladder, but the chest harbored extensive metastases.

The third patient free of recurrence died 12 months after operation from pneumonia. Just prior to the patient's hospitalization for this fatal illness, cystoscopic examination disclosed the absence of recurrence, and the retraction of the right ureteral orifice into the depths of a scar. This scarring with retraction of the ureteral orifice Corbus mentions in his experimental work. No estimation of right renal function was tabulated.

2. The living group consists of those patients who have been personally contacted and studied in the preparation of this report. They number 14, or 27.4 per cent of the entire group of 51 cases. In each a diagnosis of papillary carcinoma was made. Eleven have been free of recurrences since the original operation, from 4 to 86 months.

The observation periods of these 14 living patients are grouped chronologically as follows:

2 patients have been observed 4 to 12 months
3 patients have been observed 13 to 24 months
2 patients have been observed 25 to 36 months
4 patients have been observed 37 to 48 months
3 patients have been observed 54, 74 and 86 months

Three patients followed 26, 40, and 44 months, respectively, were found to have had recurrences. Two of these 3 recurrences were not present at our last examination, due to control by cystoscopic fulguration. The third recurrence is extensive and is being treated with roentgen therapy.

3. This group includes a total of 8 patients whom we have been unable to trace either through letters, questionnaires, or the referring physician. There was histological corroboration of papillary carcinoma in each case.

Two patients were lost at the fourth month interval. Cystoscopy revealed at that time that each had an unhealed area covered with slough.

The third patient, age 39 years, examined 15 months after operation, had no recurrence and little scarring despite a large papillary infiltrating carcinoma.

The fourth patient, 72 years of age, with an infiltrating carcinoma, who also had a concomitant suprapubic prostatectomy, had no recurrence 20 months after operation.

The fifth patient, with a large ulcerating carcinoma, was free of recurrence 22 months after operation. At this time, malignancy was discovered in his throat.

The sixth patient was free of recurrence for 32 months, when multiple papillomas appeared. These were periodically fulgurated over a period of 23 months. The patient was lost from the follow-up service after a total observation of 55 months.

The seventh patient had had a mid-trigonal lesion diathermized. A small papilloma was discovered 74 months later in the center of the scar. Following fulguration the patient never returned.

The eighth patient had a pedunculated carcinoma filling half the bladder cavity. Cystoscopy at an interval of 75 months disclosed no recurrence.

SUMMARY OF GROUPS 1, 2, AND 3

There were 29 deaths in 51 cases, a general mortality of 56.8 per cent. Five, 9.8 per cent, were considered operative deaths. From the available statistics of 23 deaths, their survival period ranged from 1 to 44 months. Three patients lived 8, 32, and 44 months but no information could be obtained of the presence or absence of recurrence; 17 patients had recurrences at the time of death, 1 to 34 months after operation, while three patients were free of recurrence 4, 12, and 24 months, after operation.

Fourteen, or 27.4 per cent, of 51 patients were alive at the time of this study. Eleven were free of recurrence with follow-up periods of 4 to 86 months; 3 had had recurrence and had been followed 26, 40, and 44 months.

Eight cases classified as indeterminate were considered separately because the final disposition of the cases was not known (5 were lost at short intervals of time). Three patients had had lengthy follow-up periods of 55, 74, and 75 months, with recurrence detected in 2.

There were 24, or 47 per cent, of the entire group of patients who gained vesical "cure and comfort" from the operative procedure. "Cure" refers to those patients, 18 in number (35.3 per cent of 51 cases), who demonstrated no signs of local recurrence irrespective of the time limit of observation. Comfort implies the absence of distressing vesical symptoms and refers to the status of 6 of our patients who had small recurrences satisfactorily controlled by cystoscopic fulguration.

TECHNIQUE OF TRANSVESICAL DIATHERMY

The bladder is opened through the customary suprapubic extraperitoneal approach. Adequate exposure of the region harboring the growth is imperative, for only in the adoption of this surgical principle can satisfactory electrosurgical work be accomplished.

Whenever possible the cautery loop electrode should be employed first to cut away the tumor, including a 1 centimeter "collar" of healthy tissue. The depth of severance extends to the muscular layers, care being taken not to penetrate the bladder wall. If there is any apprehension, extraperitoneal drainage should be used. In the basal regions, deep excision may lead to fistulous communication while diathermy *per se*, if applied too long, may establish false passages. The ureteral orifice, and a portion of the trigone and the vesical sphincter can, in our experience, with comparative safety to the patient, be excised if infiltrated with neoplasm.

Pilcher and Cabot have drawn attention to total resection of the vesical neck combined with subtotal removal of the trigone in the female with resultant normal bladder function and normal control of urination.

Following cautery excision, the flat disc electrode is very lightly applied to the denuded area and an additional 1 centimeter of peripheral healthy tissue, until the blanching of cooking tissue and muscular contractions indicate an adequate diathermic exposure. Between 1200 and 1500 milliamperes are delivered per application. At each application the electrode is lifted the moment that bubbling appears around its periphery, and it is to be accentuated that only the lightest contact with the tissue is to be applied and all actual sparking is to be avoided. Charring of tissue to a peculiar dirty green color commonly occurs in the area previously excised. In some instances, operators prefer the use of diathermy alone to control small or extensive growths.

At the conclusion of the operation, the bladder is carefully inspected for hemorrhage which, in our experience, has been negligible. If the ureteral orifice, or its immediate periphery, has been diathermized, a ureteral catheter is introduced, the end of which is brought out through the suprapubic wound and attached to a tube leading to a separate drainage bottle.

The bladder is closed about a large mushroom catheter which is not removed for a period of 2 to 4 weeks, depending upon the extensiveness of the cautery excision and diathermy. Too early removal leads to dysuria, tenesmus, and bleeding.

DIATHERMY AND IRRADIATION

In this series of 51 patients, deep roentgen therapy, radium, radon, or a combination was not

used routinely and no definite conclusions can be drawn. In isolated instances remarkable results have been achieved, while in others, no improvement was noted. Only in its routine use can a fair appraisal be given.

We urge rather than condemn surgery combined with one of the forms of irradiation. Andrews and Uhle, in a series of unselected cases of vesical carcinoma, showed that the 5 year survival period in the group treated by combined surgery and irradiation was 22 per cent compared to 7 per cent for the group managed by surgery only.

In 10 of the 51 patients constituting this report, who were followed from 40 to 86 months, 6 were treated with combined diathermy and deep roentgen irradiation. Three of these 6 patients had recurrent growths. Of the 10 patients, 4 were managed only by transvesical diathermy. One of these 4 had a recurrence of the tumor.

COMPLICATIONS OF DIATHERMY

Clinically, Counseller and Braasch have observed that none of their 17 cases had pyelonephritis secondary to diathermy despite the fact that the ureteral ostium in some of their cases was included in the electrocoagulation. They state "Complete healing occurred in every instance, leaving a clean scar with the ureteral orifice occupying a depression in the scar."

We have likewise had occasion to observe the clean scar and lack of vesical deformity left by diathermy. In some instances in which diathermy was applied in a limited small area, the scar was almost lost to view. Nevertheless, acute pyelonephritis has been a troublesome complication in a few of our cases and to avoid this a ureteral catheter is now introduced at the conclusion of the operation if the ureteral orifice or its immediate neighborhood has been diathermized.

Bumpus and Silver state: "In the transvesical series a ureteral orifice was included 29 times in the cautery destruction, and in 10 it was considered a decided factor in an unsatisfactory convalescence if not a direct cause of the patient's death."

Chronic pyelonephritis must be taken into consideration, too, for in two exemplary cases this complication has occurred secondary to ureteral orifice contracture. One patient has a recurring pyonephrosis which spontaneously empties itself into the bladder. Nephrectomy is anticipated. The second patient had an extensive papillary carcinoma of the retrotrigonal region treated with excision and diathermy. Death followed 8 months after operation. At autopsy, the bladder and its environs were grossly free of tumor, but microscopic examination revealed small nests of tumor cells in the depths of the scar tissue which was minimal considering the extensive application of diathermy. Both ureteral orifices were stenosed with resultant bilateral hydropyonephrosis. The primary cause of death was a ruptured gangrenous gall bladder and peritonitis. We, therefore, suggest to incorporate in the follow-up treatment the dilatation of one or both ureters at periodic intervals after the immediate convalescence, in an attempt to maintain adequate renal drainage and reduce the incidence of morbidity.

Only one patient developed a fistulous communication after diathermy. A vesicovaginal fistula complicated an extensive grade 3 infiltrating basal growth 5 weeks after operation. This patient survived 9 months. The cause of death was attributable to recurrence of the growth, urosepsis, and uremia.

The immediate effect of diathermy is an aseptic necrosis. If infection supervenes, various gradations of severity from the simple to the more virulent with pelvic cellulitis, phlebitis, septicemia, and death can occur.

Later in the convalescence (1 to 4 months) sloughs denuded from the operative area may lead to dysuria and even retention of urine requiring catheterization. These pieces of tissue, in our experience, have always been spontaneously voided and have never been associated with troublesome bleeding.

Shivers has recently observed ureteral reflux as a late result of diathermy.

SUMMARY AND CONCLUSIONS

1. The therapy of vesical carcinoma should be selective. Transvesical diathermy is of value in the treatment of lesions involving only the basal regions of the bladder and those not amenable to bladder resection or to transurethral management. The indications and technique of diathermy have been discussed.

2. The safety of transvesical diathermy is shown by an operative mortality of 9.8 per cent.

3. The three most important complications of diathermy are the establishment of fistulous communication between bladder and rectum or vagina, acute pyelonephritis, and chronic pyelonephritis. Fistulas can be prevented by curbing the overzealous application of the high frequency current. There was only one fistula (vesicovaginal) in our series. The incidence of acute pyelonephritis can be reduced by the introduction of a ureteral catheter for drainage at the conclusion of the operation if diathermy has been applied directly over, or in close proximity to, the ureteral

orifice. Stenosis of the ureteral orifice secondary to healing fibrosis is a later manifestation of the effects produced by surgical diathermy. Renal morbidity (chronic pyelonephritis) can be lessened by periodic ureteral dilatation during the period of the patient's follow-up.

4. Diathermy produces an aseptic necrosis. If infection supervenes the progression of pathological events ranges from the simple to the fulminating type with pelvic cellulitis, pelvic phlebitis, and death.

5. Cicatricial reaction following diathermy does not produce marked vesical deformity. In spite of extensive diathermy, scarring is often minimal, and in 47 per cent of patients vesical comfort and silence can be acquired.

6. There was a general mortality of 56.8 per cent. Death was ascribed in this group to recurrence of the growth with secondary renal infection and uremia. Other contributory factors were distant metastases, unhealed suprapubic sinuses, and septicemia. Cordotomy was performed in 1 case for relief of intractable pain.

7. No evidence of recurrence, irrespective of the time limit of follow-up, was found in 35.3 per cent. Recurrent growths developed in 43.1 per cent.

8. Routine cystoscopy, after operation, is of great importance in detecting early or late recurrences. In 1 instance a papillary recurrence was found 74 months after the original operation. Cystoscopic fulguration is sufficient to effect control.

9. The importance of an efficient follow-up service cannot be overemphasized. Ten patients, 19.6 per cent, were followed from 40 to 86 months. Four had recurrences and 6 were free of recurrence.

10. We have been unable to substantiate the figures of Counseller and Braasch (88 per cent living over 5 years and free of recurrence), but feel that the results of diathermy in the treatment of carcinoma of the bladder are significant and should foster a wider clinical interest in this method of treatment.

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EDITORIALS

SURGERY
Gynecology and Obstetrics

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MAY, 1938

SOME SCANDINAVIAN CLINICS

THE Society of Clinical Surgery which makes a trip to foreign surgical clinics every five years or so, went to Scandinavia during the summer of 1937. These countries were chosen partly on account of a belated recognition of the fine scientific work which has been carried on there for many years, partly on account of the desire to see the workings of the "Middle Way," partly on account of their freedom from the threat of war, and partly, it is necessary to confess, on account of their scenic attractions. The choice proved a happy one, combining profitable professional experience with the delight of beautiful scenery.

The scientific contacts between the Scandinavian countries and our own have been rather remote until recent years. These nations traditionally looked to Germany and the British Isles in medicine as they did in commerce. Recently awards of the Nobel prize in medicine across the Atlantic have provided evidence of the attention that medical progress in this continent has been gaining there. While on our part, the work of men like Krogh in physiology, Svedberg in chemistry, and the clinical investigation in centers like the Radiumhemmet and the Finseninstitute have impressed us with the caliber of the medical sciences in Scandinavia.

In surgery this community of interest has been shown by the appearance of several of the outstanding Scandinavian surgeons such as Einar Key, Gunnar Nyström, and Knut Giertz, as the principal guest speakers before the American Surgical Association and other important surgical meetings. Scandinavian contributions to the progress of surgery have been outstanding in many fields, particularly in the operative treatment of tuberculosis, in embolectomy, in traumatic surgery of bone, and in the practical development of radiation therapy. The recent untimely death of Professor Christian Jacobæus recalled the many contributions of this great internist in the field of pulmonary disease, including his pioneer work in devising a method of dividing intrathoracic adhesions.

Outstanding centers of surgical interest are the clinics in the three capitals, Stockholm, Copenhagen, and Oslo, the University Clinic at Uppsala and that of the Sahlgrenska Sjukhus in Göteborg. Nearly all of the hospitals are of the pavilion type in extensive grounds made beautiful in the summer time by a profusion of luxuriantly blooming flowers. However, some of the most recent additions, such as the new Pathological building at the Sabbatsberg Sjukhus, are excellent examples of the modernistic style that one sees extensively in the attractive co-operative apartment buildings. The hospital wards were neat but usually plain while the operating rooms were uniformly well

equipped with excellent rustless steel instruments. Interesting clinical programs given by the speakers in English, were arranged most courteously for the Society by all of the chief surgeons of the clinics visited. In Sweden's western seaport city, Göteborg, Dr. Johansson gave an impressive demonstration of his method of treating medial fractures of the femoral neck by extra-articular osteosynthesis. We were interested to see that the Finseninstitute in Copenhagen had become also a radium center where the treatment of carcinoma was receiving almost as much attention as all forms of surgical tuberculosis. The Institute represents the perpetuation, under modern conditions and with government support, of the work of a universally beloved pioneer. Finsen's achievement in establishing this Institute is all the more remarkable as he was seriously ill at the time, dying, in 1904, of pericarditis. Lupus, extremely prevalent when he did the initial work with ultra-violet treatment, has now become relatively uncommon even in Denmark and ultra-violet radiation no longer plays the outstanding rôle that it once did in the Institute's therapeutic program. Patients with surgical tuberculosis are still given carbon arc light baths for an hour daily for its general effect. But with the diminution in surgical tuberculosis, the Institute has enlarged its program and the treatment of all types of neoplasm is carried out.

Many interesting clinical investigations were described to us in the various clinics. Dr. Chievitz reported the removal of a parathyroid tumor which was found in the mother because its presence had resulted in tetany in her nursing baby. Dr. Crafoord described the use of a purified heparin as an anti-coagulant, given intravenously to the donor before withdrawing blood for transfusion. In Dr. Berglund's medical clinic there was given an excellent demonstration of the newer methods of studying the stomach and pancreas including gastroscopy and the response to secretin. Perhaps the most interesting innovation in diagnostic study was the method worked out by the late Professor Jacobæus with Drs. Björkman and Frenckner. This procedure called bronchospirometry determines the respiratory function of each lung separately. It is already yielding data of great value both scientifically and also clinically in directing therapeutic measures. Thus it has been found that the functional capacity and roentgenographic appearance of the diseased lung may be significantly at variance.

The Radiumhemmet in Stockholm is probably the most famous center in the world for the irradiation of malignant disease. Like the Finseninstitute, it is a living memorial to the vision, energy, and devotion of its founders; in this case two men, one dead and one still living, Dr. Berg and Dr. Forssell. There are many fine features of the splendid work being done there, the organization of the clinics, the skill in devising apparatus and in measuring physical effects, the impartiality in judging between all alternative methods of treatment, the quantity of radium available (about 10 grams in all, of which 5 grams are in one bomb), and the persistence with which even apparently insurmountable obstacles are attacked. But the most impressive feature of the clinic was the remarkable following of cases. Less than 10 per cent of all their thousands of cases are lost track of. And in some series including over 500 patients, the result in every case treated is known to date. This remarkable record is to be credited to several factors. In the first place, the energy and devotion of the doctors following individual groups and the efficiency of the follow-up system used are important. In the second place, there are significant sociological factors in the respect and obedience of the

Swedish people to constituted authority and in the relative stability and official recording of the place of residence of the people. And in the third place, governmental socialization assists, by making it possible to transport indigent patients from any distance to the clinic without cost to themselves.

The outstanding surgical feature in Oslo was the demonstration by Professor Holst of his method of extrapleural apicolysis combined with thoracoplasty for the obliteration of tuberculous cavities in the upper lobe. In Bergen we had visible evidence of a splendid medical victory: large institutions built for the care of hundreds of lepers today only have one or two remaining patients.

One of the most interesting features of the Scandinavian visit was the opportunity to see the impact of a plan for national socialization upon the practice of medicine. Probably no two members of the group came away with just the same impressions concerning this. But the following general conclusions seem valid. An excellent grade of surgery in general obtains today in the best Scandinavian clinics, and the medical profession occupies a position of high esteem in the community. However, there are some difficulties in medical practice already apparent that may be inherent in this type of organization or may only require certain adjustments. Most of the doctors must either seek and obtain hospital positions (on state or municipal salaries) or must support themselves by the care of a regulated number of state insurance cases at approximately $2.25 per person a year, as the amount of private practice is almost negligible (except for a very few specialists). In either of these cases, this results in a very small cash income for the greater part of the doctor's professional life. Although with the aid of co-operative buying and the provision of quarters and food by many hospital positions, his income is usually adequate for a fairly comfortable livelihood, it rarely allows for such important educational elements as visiting foreign clinics or other "brain dusting" opportunities. Another difficulty in working such a plan appears in the following situation: A separate group of physicians has had to be appointed for emergency night calls as it has become practically impossible to get a doctor after six p.m. for one of his state insurance cases. It was even difficult to obtain a narcotic prescription as an emergency in the evening for one of the doctors in our party. Thus the concerted action of the profession in attempting to overcome one unfortunate effect of the system has resulted in a lowering of the quality of the service rendered in another direction to the public.

There is one suggestion which should be made to those planning a trip to the Scandinavian countries including the visiting of its hospitals and clinics. Due to the many months of short days, everyone there takes the maximum possible advantage of the luxuriant summer season. Consequently, for the months of July and August the work in medical institutions is on a very restricted vacation schedule. Thus if one wishes to combine a scenic summer vacation with an opportunity of seeing Scandinavian surgery, the trip should be planned to visit the Scandinavian clinics either in the latter part of June or the early part of September. W. J. MERLE SCOTT.

ETHER ANESTHESIA

ETHER anesthesia induced by the open drop method is still the best method of general anesthesia in the hands of the average person. Not infrequently it should be resorted to even by expert anesthetists when the results which they are attempting to obtain by some other method of anesthesia are unsatisfactory both from the standpoint of

relaxation and from that of quiet respiration. This is especially true when less potent agents than ether are being used and when a more complicated method of administration is being persisted in after the entire surgical team realizes that satisfactory anesthesia has not been accomplished.

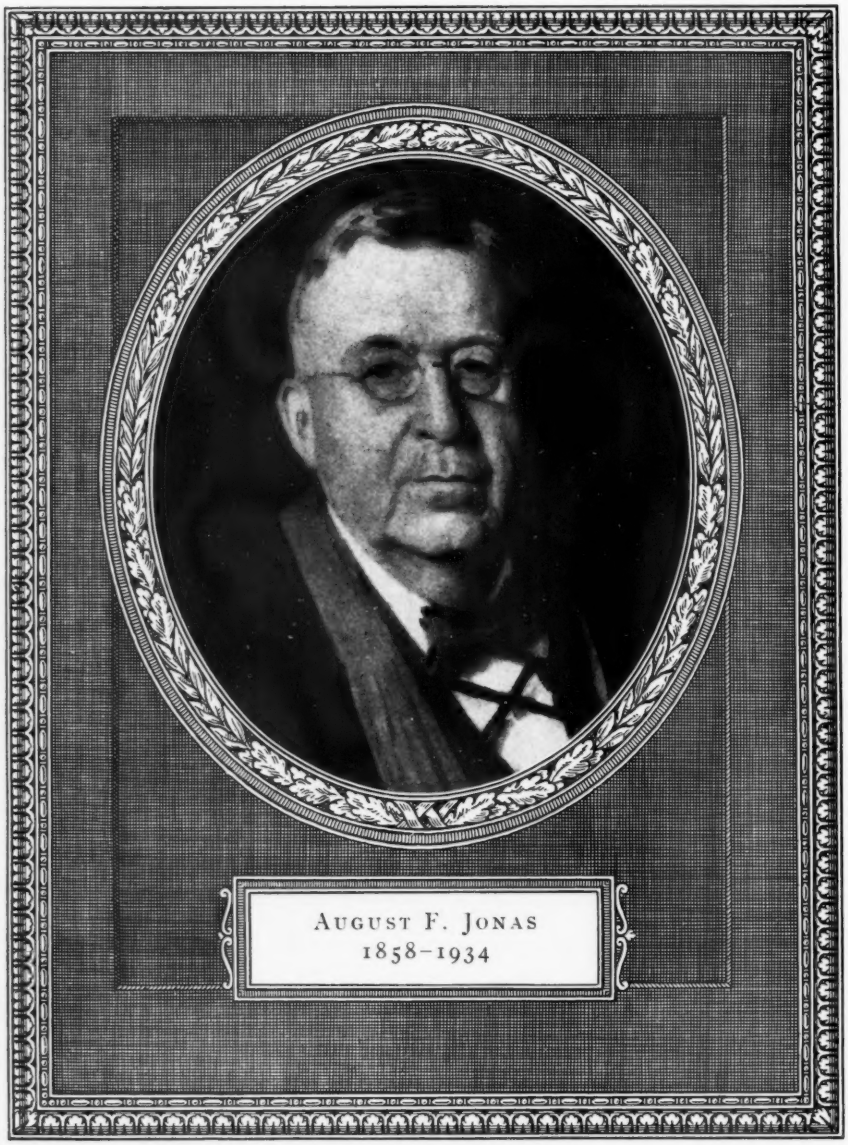
It will also be found in a certain number of cases in which anesthesia using a gas machine does not produce relaxation and quiet breathing that this can be accomplished by administering ether by the open drop method. In many instances even fifteen to thirty minutes of anesthesia with ether by the open drop method will permit further maintenance of anesthesia with a gas.

There has been a tendency in the last few years to advocate the use, almost routinely in many cases, of new agents and methods which are incapable of producing entirely satisfactory anesthesia in all cases. As a side result of this, some anesthetists who have received their training in the last few years have not had an opportunity to become skilled in the administration of ether by the open drop method. This is without doubt a mistake that will sooner or later have to be rectified, and it seems timely now to advocate that all anesthetists, of whatever degree of skill, keep themselves well trained in the use of ether by the open drop method. They should in turn insist that their students and all others who come under their influence also become proficient in the administration of ether.

Anesthetists should not feel chagrined in going from other methods to drop ether anesthesia if conditions are unsatisfactory and if the patient's physical condition permits. On the other hand, they should feel that they have exhibited good judgment in adapting the anesthetic to the patient rather than the patient to the anesthetic, and in thereby providing the surgeon with conditions under which he may have the best opportunity to produce maximal surgical results.

This must not be interpreted to mean, however, that administering ether by the open drop method does not have its disadvantages and that there are not numberless cases when other methods are to be preferred and when they are entirely satisfactory. For that small percentage of cases in which difficulties do arise, however, they can be eliminated by the use of ether by the open drop method. In such cases, therefore, and in the hands of the average person, anesthesia by the open drop method is a satisfactory method. Let the anesthetist turn to this method and not avoid it as one that he should be ashamed of.

JOHN S. LUNDY.



August F. Jonas
1858–1934

MASTER SURGEONS OF AMERICA

AUGUST FREDERICK JONAS

ON June 12, 1858, August Frederick Jonas was born of German parentage in Columbia county, Wisconsin. His parents came to Wisconsin from Germany in the thirties of the last century, while they were still in their teens. In his infancy, the parents moved to Madison and there August Frederick was reared and educated.

As a boy in his middle teens he worked in a drug store in St. Ansgar, Iowa, and there among the mysteries of a pharmacy of pioneer days was born the desire and determination to study medicine. Guided by the idea that eclecticism meant something in advance of other systems of medical education and practice, he entered Bennett Medical College, Chicago, attended two courses of lectures and was graduated therefrom in the spring of 1877, at the age of 19 years. His first practice was at Sauk City, Wisconsin. Sauk City was settled by Germans who left Germany following the student revolution of 1848 and 1849 and their cultural influence was an inspiration to Dr. Jonas and he always felt that his five years at Sauk City profoundly influenced his subsequent life.

Medical education in the seventies was for the most part wholly unregulated by law and the prevailing system consisted of three years of study under a preceptor, including attendance at two courses of lectures at a medical college, before coming up for graduation. Becoming dissatisfied with his medical training, feeling that he had failed to get the best and most up-to-date in the medicine of that day, he went to Berlin, Vienna, and Paris for postgraduate study and to Munich in 1882, where he spent 2 years in Ludwig-Maximilian University and was graduated therefrom, *Magna cum Lauda* in 1884.

Returning to Wisconsin in the fall of 1884 he located at Madison and remained there 2½ years. He desired a larger field and believed the size and importance of Madison would not satisfy his ambition to develop a worthwhile surgical practice, so he decided to take Horace Greeley's advice, "Go west."

In the spring of 1887 he located in Omaha, then as now, a growing city of much promise in the rapidly developing Middle West. Subsequent events proved his judgment sound, for here he was to carve a career the memory of which shall long endure. Here he married Dr. Metha Helfritz of St. Ansgar, Iowa, to whom, as a youth, he had revealed his ambition to study medicine and from her he received inspiration and encouragement to pursue that course. After marriage she practiced with him during the 6 years preceding her death.

Dr. Jonas was one of the first to bring the message of antiseptic and aseptic surgery to Omaha. He early became interested in the then struggling Omaha Medical College, the immediate predecessor of the present Nebraska University College of Medicine and in 1892 he was made professor of clinical surgery. His active connection with the medical school as a teacher of surgery under various titles continued for 35 years. He was dean from 1898 to 1902. On retiring from the active work of the school in 1928 he was made professor emeritus and the same year the Nebraska University conferred upon him the honorary degree of LL.D.

Dr. Jonas' work as a pioneer surgeon and teacher exerted a profound influence on Nebraskan and mid-western surgery. As a surgeon he was conservative. As an operator speed and certainty were his gifts.

Additional hospital facilities were greatly needed in Omaha during the early residence of Dr. Jonas. The matter was brought to a crisis (in 1891) when Dr. Jonas made a proposition to the Methodist Church, then contemplating a new hospital, to give one-half of his fortune at that time, if the Church would match it. The hospital was built. His contribution was said to have been thirty thousand dollars and his later contribution to the Methodist Hospital during his lifetime largely exceeded that amount. On opening of the hospital Dr. Jonas was made chief surgeon for life.

In 1898 Dr. Jonas was appointed chief surgeon of the Union Pacific railroad and held the position for 27 years until failing health caused him to resign. He almost wholly reorganized the medical department of the Union Pacific and its system of case records. "His work in this position has been outstanding as an administrator and as a surgeon with the result that the medical department under his jurisdiction is one of the best in the country." So wrote President Carl R. Gray.

Dr. Jonas always took an active interest in medical organization and rarely missed a meeting. He appeared frequently on the programs and rarely missed an opportunity to take part in the discussion of surgical subjects and his contributions were always worthwhile. The Missouri Valley Medical Society, organized in 1888, was for many years the foremost medical society in all that territory tributary to the Missouri valley. Dr. Jonas was a charter member and its president in 1894. He served the Western Surgical Association as president and at sometime was vice-president of the American Surgical Association. In the early nineteen hundreds he was vice-president of the American Medical Association and sometime chairman of the surgical section of the same body. He was a member of the Pan American Medical Association and attended the meeting held in Mexico City.

In 1905-1906 Dr. Jonas was president of the Nebraska State Medical Association. He was one of the organizers of the present Omaha-Douglas County Med-

ical society and one of its early presidents. He was one of the organizers of the American College of Surgeons and always stood high in the councils of that organization. He was a member of the Société Internationale de Chirurgie.

During the World War, the Governor of Nebraska appointed Dr. Jonas special medical adviser to the governor with the rank of Captain. He was instrumental in the organization of Base Hospital No. 49 and in the organization of an Ambulance Corps from Nebraska.

Dr. Jonas was a tireless worker in his chosen field and for many years carried what amounted to a double load, a large private surgical practice and the chief surgeonship of a great railroad system, as well as instructor in surgery at the University Hospital.

He was generally considered one of the ablest surgeons of the Middle West and was well known as a surgeon all over this country and in Europe. He was a frequent contributor to medical literature. Collections of his reprints are to be found in several of the larger libraries. He wrote a chapter for Binnie's *Surgery*.

Of the opinion that a doctor should have interest aside from his profession as a relaxation, Dr. Jonas early became interested in mineralogy and geology and made a collection of minerals which ranks among the finest in the state.

In 1907 after a visit to Egypt, he became deeply interested in archeology and began to make a collection of Egyptian antiquities which contains many articles of historic interest and value. This collection has been presented by the family to the Joslyn Memorial in memory of Dr. Jonas. It will occupy a small room there.

Dr. Jonas spoke and read German and French with ease. He was a man of simple tastes and had high ideals of life. "Small talk" was not for him. He was a man of affairs and supported every movement looking to the growth and improvement of Omaha.

In 1907 Dr. Jonas and Miss Jessica Stebbins were married in Denver and the latter survives. To this union were born a daughter, recently married to Dr. Harold Gifford, Jr., son of the late prominent ophthalmologist, and two sons: one Dr. August Frederick Jonas, Jr., at present on the staff of the Johns Hopkins Hospital.

Dr. Jonas suffered a cerebral hemorrhage in 1927 resulting in an aphasia, from the effects of which he never fully recovered. He uncomplainingly accepted a life of impaired usefulness and invalidism. His greatness was most definitely expressed by the splendid way he met this challenge. He died November 1934, from a cerebral hemorrhage suffered two days before. F. A. LONG.

EARLY AMERICAN MEDICAL SCHOOLS

HISTORICAL SKETCH OF THE JEFFERSON MEDICAL COLLEGE

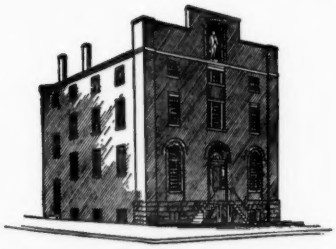
DAVID M. DAVIS, M.D., Philadelphia, Pennsylvania

IN 1767 the entrance requirements of the first American medical school were established as a degree from a collegiate institution or evidence of enough knowledge of Latin, mathematics, and natural and experimental philosophy as might be judged requisite to a medical education, and a general knowledge of pharmacy. In addition, there must have been a sufficient apprenticeship to some reputable practitioner. This indicates that at the time medical education began in America, medicine was seriously regarded as a learned profession. Owing to a lack of other resources, it was necessary to finance these schools by means of the fees paid by the students, and as enrollments grew, the teaching of medicine became not only a source of honor and renown, but a very lucrative occupation as well. Talented and ambitious young men were eager to take part in it, and when existing schools afforded insufficient opportunities, new schools were projected.

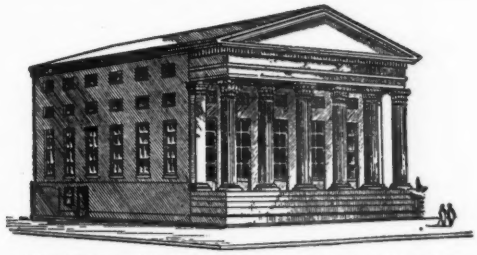
Dr. George McClellan, Founder of the Jefferson Medical College. (From a daguerreotype.)

The Jefferson Medical College arose from such a project, in which a remarkable young man of 29 years, named George McClellan, was the leading spirit. Opposed by the University, already old and proud, the project could not be consummated until the trustees of Jefferson College in Canonsburg, Pennsylvania, had been persuaded to lend it their protection and the authority of their charter. The school opened in 1825 and was an immediate success. To McClellan belongs the credit for inventing clinical teaching and from the beginning he maintained a small dispensary—at first in a room which also served as the Dean's office—where students could observe clinical material. This room was in a reconstructed theater, but in 1828 a new building for the faculty was erected by one of the trustees at Tenth and Sansom Streets, where the school has remained ever since. In 1838, a separate charter was obtained and the association with Jefferson College ended.

McClellan, the son of one famous soldier and the father of another, was a brilliant surgical genius, a splendid teacher, and a man of great energy. When representations had to be made to the Legislature, he went to Harrisburg himself, driving his own chaise, and wearing out several horses on the journey. His able colleagues on the original faculty were John Eberle, B. Rush Rhees, Jacob Green, Nathan R. Smith, and Francis S. Beattie. His "positive, emphatic, and enthusiastic" qualities were undoubtedly accompanied by a good deal of impatience and arrogance as, in spite of the luster he lent to the school, there was constant dissension in the faculty, with frequent changes. In 1841 the trustees took matters in their hands, and reorganized the faculty. McClellan refused to join in the reorganization, and left to found another school which drew to it a good many Jefferson students at first but finally vanished from the scene. The 1841 faculty consisted of Muetter, Pancoast, Dunglison, Huston, J. K. Mitchell, Meigs, and Bache. That McClellan was a stormy petrel is further evidenced by the fact that with his departure dissension was replaced by co-operation, the school prospered mightily, and no further changes occurred until 1856, when death intervened. As the famous and successful professors retired or died, they were replaced by others equally competent, so that the school enjoyed an uninterrupted growth in prestige and authority for more than half a century and had a reputation second to none in the world. McClellan's principles of clinical teaching and constant actual contact between student and patient were followed from the beginning and had much to do with this success. The 1828 building contained a small dispensary in which operations were also performed, and in 1844 two rooms over a shop adjoining the school were rented for the reception and care of patients after they had been operated on in the clinic. These primitive hospital facilities were enlarged until they included two entire floors, and their value proved to be such that in 1877 they were replaced



The first building occupied by the Jefferson Medical College in Philadelphia, 1828.



The Jefferson Medical College, as it appeared in 1846.

by a commodious hospital building, which was the property of the medical school and created entirely as an adjunct to the teaching of medicine. Group teaching in the dispensary was utilized at first, but as the first class numbered 109 it had to be supplemented by the clinic, in which the patient was brought to the amphitheater and exhibited to large numbers of students. At an early date, clinics were also given at the Pennsylvania and the Philadelphia Hospitals.

Jefferson's renown through this long period can be expressed in the renown of the members of its faculty. In medicine there were Robley Dunglison, J. K. Mitchell, Roberts Bartholow, and Jacob M. DaCosta. In surgery, Thomas Muetter, Joseph Pancoast, Samuel D. Gross, Samuel W. Gross, John H. Brinton, and William W. Keen. In obstetrics, Charles D. Meigs and Theophilus Parvin. Muetter collected his famous museum, now the property of the College of Physicians of Philadelphia. The incomparable Gross organized the American Surgical Association and the Philadelphia Academy of Surgery. Meigs was a prolific author, highly respected and liked in Philadelphia, but at present better known to the world at large for his luckless polemic with Oliver Wendell Holmes concerning the contagiousness of puerperal fever.

The success of the school and its constantly growing student body eliminated financial difficulties for a long time and helped to attract the eminent men who joined the faculty. On the other hand, there was a huge and growing demand for medical education, new medical schools were arising everywhere, and medical education was gradually descending toward the chaotic period of 1870–1890, when cupidity reigned and proprietary abuses were at their peak. Jefferson could not escape the effects of this trend. At the beginning, in 1825, 1 year of apprenticeship and 2 years of lectures had been required. This shows that there was already much recession from the scholarly requirements of 1767, but in 1857 there was a further relaxation to 2 years of apprenticeship and 1 year of lectures, and nothing was said in the catalog about the character of the apprenticeship. The period of lectures in each year covered only 6 months. The faculty conscientiously strove against this tendency, but economic considerations forbade them to increase the requirement for graduation. Instead they established a supplementary course of lectures covering 4 additional months each year and given without extra fee. All students were urged to attend it, but it was not compulsory. In addition, a student might attend a third year of lectures without charge. In other words, a good medical education was provided for those with the will to take it, but the others could still obtain a diploma after 6 months' attendance at lectures. It must be remembered that similar conditions prevailed in all other medical schools. Jefferson led in efforts to correct this lamentable state of affairs, as in 1872, long before any general campaign for improvement had begun, students were urged in the catalog to take their entire 3 years in Jefferson and to make their studies progressive. In 1879 the regulations of the newly formed Confederation of American Medical Colleges were adopted, and 2 years in medical school again required. In 1890, simple entrance requirements were initiated, and 3 years in medical school made compulsory. Since then the elevation of standards has continued steadily, along with those of other schools, and for many years they have been second to none.

The progress of medicine was closely followed. Before 1835 a museum of normal and morbid anatomy had been begun and in 1878 a separate pathological museum was added. In 1879, a new laboratory building was opened, the finest in the country at that time. In 1886, practical instruction in obstetrics, laryngoscopy, and ophthalmoscopy was instituted. In 1895, Jefferson pioneered with a required 4 year course. In 1896, X-ray equipment was installed and with the aid of the alumni the laboratory building was enlarged and re-equipped. This rising tide of necessities made huge demands on the financial resources of the institution, and it became more and more difficult to obtain contributions from the state or from individuals in view of the custom of dividing the surplus each year among the professors. The practice, in vogue everywhere at the time, began to be vigorously attacked from within the faculty, and in 1895 it was formally abandoned, to the satisfaction of everyone concerned.

In the last years of the Nineteenth Century and the first of the Twentieth, the stature of the school is indicated by the illustrious names connected with

it, such as Hobart Amory Hare and Thomas McCrea in medicine, J. Chalmers Da Costa and Gibbon in surgery, Solis-Cohen in laryngology, deSchweinitz in ophthalmology, Stelwagon in dermatology, Dercum in neurology, and Jackson in bronchoscopy. The Medical School building was greatly enlarged in 1909, and in the same year a new hospital of 300 beds was opened. In recent years three fine modern structures have been added—a new medical school, a fourteen-story addition to the hospital, and the Curtis out-patient clinic. There are also separate buildings for the departments of anatomy and of diseases of the chest.

The Jefferson of today clings to tradition in that its methods of instruction have undergone less radical changes than those of many other institutions. It is proud of its successful career in the absence of any university connection. It is strong in the belief that it will continue to have, as in the past, such success as is deserved by the men who compose its staff.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IT IS certain that nearly every one who is interested in pulmonary tuberculosis or thoracic surgery already owns Alexander's *Collapse Therapy of Pulmonary Tuberculosis*[1] and is already aware of its excellence. Most have known that it was being prepared and have awaited its publication with curiosity and impatience—curiosity not as to its value (that was taken for granted) but as to its exposition of the present practice of the author and his evaluation of the practice of others.

A review, therefore, cannot be of value in describing and recommending it but does afford an opportunity of paying a tribute to its author and of analyzing his important position in the development of collapse therapy in pulmonary tuberculosis.

As one examines the history of the dissemination of medical ideas he is impressed with the reality of the barrier between nations and the necessity that in each country each new thing has its protagonist and popularizer. All of the measures of collapse of the lungs were developed in Europe and, with the single exception of artificial pneumothorax, had been in use there for many years before they were adopted in this country. Even pneumothorax, which was used here by Murphy and Lemke in 1898 and 1899, was soon abandoned and had to be reimported from Germany as late as 1912.

The surgical measures were only beginning to be used in America when, in 1925, Alexander's first book, *The Surgery of Pulmonary Tuberculosis* made its appearance. This afforded a necessary stimulus and immediately established its author as the leader of the advocates of this form of treatment—a position which he has since maintained. Besides contributing to the evolution of the procedures, he has made his department at the University of Michigan a proving ground for the new ideas of others. While many American surgeons were refusing to try this operation or the other, because they felt that it would not work, Alexander has tried them all and has helped to establish many as valuable. In doing this he has been meticulous in giving credit to the originators.

At the same time he has given a thorough training to a succession of young men from this country and abroad. In England and in many cities in America thoracic surgery has been stimulated and its direction influenced by men trained at Ann Arbor.

Until recently Dr. Alexander has been a full time surgeon at the medical school of the University of Michigan. One wonders to what extent the freedom from the uncertainties and the time-consuming vexations of private practice have contributed to his work. As one looks over the list of American surgeons who are making important contributions to the science he is impressed with the fact that most of them occupy such positions. Alexander, Graham, Wangensteen, Ochsner, Whipple, Phemister, Cole, Churchill, Heuer, and Holman, are a few of an imposing list.

To return to the book under discussion, one cannot avoid making a few statements concerning the question of indications. On this subject there is, and probably always will be, a divergence of opinion, and it would be surprising if every one or, in fact, any one agreed entirely with Dr. Alexander. It would be out of place for the reviewer to express here his disagreements further than to say that the advisability of using phrenic nerve block in preference to pneumothorax, even in cases in which it is likely to prove effective, is very questionable; that the author's scant enthusiasm for the Semb apicolysis is not shared by most other surgeons and that his advice to proceed early to drainage of secondarily infected tuberculous empyemas is probably pernicious. On many of these questions the wise clinician will continue to withhold judgment and so avoid the deadening of curiosity which follows a formed opinion.

JEROME R. HEAD.

THIS book, *J. B. Murphy, Stormy Petrel of Surgery*,[2] by Loyal Davis, is one of the most interesting contributions to surgical history that it has been my privilege to read. It tells the story of the life and work of a man who did as much to advance modern surgery as any one whom I have known, and the story is a stimulus to all who believe in the opportunity which America offers to the young man. To the older men of the disappearing generation who knew Murphy, it is a source of satisfaction that Murphy's example and achievement have been so well placed in print.

In the eighties of the Nineteenth Century, the work of Pasteur and Lister began to permeate American medicine. In the early stages there was so little understanding of the germ theory of disease that its application resulted rather in a ritual than in the use of aseptic and antiseptic methods. The carbolic acid spray appeared and disappeared, and other usages and procedures, futile or harmful, arose and vanished.

In the nineties came rapid advance in the sound application of the new knowledge to the science and art of medicine. In the spread of the new doctrine, Christian Fenger, of Chicago, a Dane, educated in

[1] THE COLLAPSE THERAPY OF PULMONARY TUBERCULOSIS. By John Alexander, B.S., M.A., M.D., F.A.C.S. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

[2] J. B. MURPHY, STORMY PETREL OF SURGERY. By Loyal Davis, M.D. New York: G. P. Putnam's Sons, 1938.

the Scandinavian seats of learning, demonstrated the principles of surgical pathology, and John B. Murphy became a leader in applying the new knowledge to general surgery.

During the Haymarket Riot in Chicago, in 1886, newspaper comment first brought Murphy into the picture because of the daring surgery he undertook in rendering aid to the injured, and his success, especially in the traumatic surgery of the abdomen, was dramatic.

Murphy's scientific interest in many fields was phenomenal. In each field of work he made thorough preparation by preliminary experimentation and by careful study of surgical anatomy and pathology. His brilliant work helped lay a foundation for the great surgical advance of the succeeding years. The Murphy button, a mechanical device which started gastro-intestinal surgery on its way; his work on surgery of the blood vessels and of the nervous system; on the thorax, on the bones and joints, and on the endocrine system, followed one after another in papers, discussions, and clinical lectures.

Murphy was the greatest teacher of clinical surgery I have ever known. A kindly, friendly man, whom it was the good fortune of my brother Dr. Charles and myself to call friend as well as teacher, we look back to him with gratitude and loving remembrance. We would strongly urge every young man going into medicine and surgery to read Loyal Davis's life of Murphy, for in it he will find courage and inspiration, even when conditions appear most adverse.

W. J. MAYO.

TO fill a need for a combined text and atlas of hematology,[1] Kracke and Garver have written a comprehensive volume. The first section of the book is devoted to a discussion of the principles of terminology and includes a dictionary of hematological terms. Many new terms based on Latin or Greek roots are recommended; for example, neutrocyte is preferred to neutrophil. Other new terms include acidocyte (eosinophil), basocyte (basophil), fragilocyte, meniscocyte, polychromatocyte, etc. Individual blood cells are then described and illustrated by colored drawings. For the most part, the drawings are quite realistic and should assist greatly in identifying individual cells on blood films. The blast cells do not appear quite so realistic, as they do not contain the fine chromatin structure that is usually seen in the nucleus. The colored plate of supravitally stained leucocytes is good. The illustrations of blood films that accompany the clinical discussion of the various blood diseases is one of the best features of the book. These blood films have been well chosen and represent clearly the hematological characteristics of the individual disease. They should prove of great value in assisting the physician to interpret what he sees in the microscope.

The clinical and laboratory phases of the various blood diseases are discussed in detail. Very recent advances are included, and the authors frequently express their own opinions and experiences. Dr. James J. Clark has written a chapter on roentgenologic treatment of the leucemic states; Dr. Francis P. Parker on blood groups and blood transfusions; Dr. Elizabeth Gambrell on malaria; and Dr. R. P. Custer on bone marrow. Hematological technique is described in detail in the concluding chapter.

There are a few things that are open to criticism. Although the expression of hemoglobin in grams per 100 cubic centimeters is considered an advantage, the authors use percentage hemoglobin and the grams per 100 cubic centimeters interchangeably throughout the book. It is also noted that little attention is paid to the saturation index or hemoglobin concentration of erythrocytes. In the text, the terms hyperchromic, monochromic, and hypochromic, refer to the hemoglobin content of cells and not to the concentration. However, in plate XII, red cells labeled as hyperchromic apparently have an increased hemoglobin concentration. It is not generally agreed that such cells actually occur. The etiological classification of anemia used is very similar to that of Minot and Castle. The discussion of the anemias in no way follows the classification. A large variety of anemias that are associated with a low color index are included under the term hypochromic anemia. This is confusing as it has become common to associate hypochromic anemia with iron deficiency. Following hypochromic anemia in order, idiopathic hypochromic anemia, hemolytic jaundice, hypochromic anemia of lead poisoning, pernicious anemia, macrocytic anemia, aplastic anemia, and sickle cell anemia are described. The reason for this arrangement is not clear. A feature of questionable value is the inclusion of a classification of anemias of childhood. These could well be discussed under the general headings of anemia. As the book is meant for reference purposes, it is lamentable that more space was not given to the anemias of bone marrow damage and dysfunction, e.g., Banti's disease and leuco-erythroblastic anemia associated with metastatic carcinoma, xanthomatoses, etc.

Outside of the above criticism, the book contains much to recommend it. In its scope, the work is unique in this country. The book will certainly fill a useful place at the bedside, in the clinical laboratory, and in the student laboratory.

HOWARD L. ALT.

[1] DISEASES OF THE BLOOD AND ATLAS OF HEMATOLOGY; WITH CLINICAL AND HEMATOLOGIC DESCRIPTIONS OF THE BLOOD DISEASES INCLUDING A SECTION ON TECHNIC AND TERMINOLOGY. By Roy R. Kracke, M.D., and Hortense Elton Garver, M.S. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1937.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

FREDERIC A. BESLEY, Waukegan, Illinois, *President*
HOWARD C. NAFFZIGER, San Francisco, *President-Elect*
HENRY W. CAVE, *Chairman;* HOWARD A. PATTERSON, *Secretary, Committee on Arrangements*

THE 1938 CLINICAL CONGRESS IN NEW YORK AND BROOKLYN

THE surgeons of Greater New York are planning to provide a program of surgical clinics and demonstrations that will present a complete showing of their clinical activities in all departments of surgery in that great medical center during the twenty-eighth annual Clinical Congress of the American College of Surgeons, October 17–21. The Committee is assured of the hearty co-operation of the clinicians at the five medical schools and more than fifty hospitals that will participate in the clinical program. Members of the Executive Committee in charge of arrangements are:

HENRY W. CAVE, *Chairman*
HOWARD A. PATTERSON, *Secretary*

FRANK E. ADAIR
FRANK E. BERRY
ROBERT E. BUCKLEY
RALPH COLP
WILLIAM DARRACH
CARL EGGERS
GEORGE J. HEUER
CHARLES GORDON HEYD
ROBERT H. KENNEDY
SAMUEL J. KOPETSKY
JOHN A. MCCREERY
DONALD E. MCKENNA
JOHN J. MOORHEAD
EUGENE H. POOL
JAMES I. RUSSELL
MORRIS K. SMITH
J. BENTLEY SQUIER
BYRON STOOKEY
GEORGE GRAY WARD
BENJAMIN P. WATSON
CARNES WEEKS
JOHN M. WHEELER
ALLEN O. WHIPPLE
PHILLIP D. WILSON
ARTHUR M. WRIGHT

A preliminary schedule of operative clinics and demonstrations is being prepared by the Committee for publication in an early issue of SURGERY, GYNECOLOGY AND OBSTETRICS. Clinics will be arranged for the afternoon of Monday, October 17, and for the mornings and afternoons of each of the four following days, in which all departments of surgery will be represented.

The final program of the Congress will present an ample and carefully arranged schedule of operative clinics, demonstrating the technique of a wide variety of surgical procedures, and will include a series of demonstrations at the medical schools and the larger hospitals for the presentation of work being done in many special branches of surgery, such as fractures, cancer, traumatic surgery, neurosurgery, plastic surgery, orthopedics, etc. The program will be so arranged that the visiting surgeon may be assured of the opportunity to devote his time continuously, if he wishes, to clinics dealing with those subjects in which he is most interested.

Programs for a series of scientific sessions, symposia and conferences, to be held daily at headquarters at the Waldorf-Astoria Hotel, are being prepared by the Executive Committee of the Board of Regents. On Monday evening the retiring president, Dr. Frederic A. Besley, will deliver the presidential address, and the new officers will be inaugurated: Dr. Howard C. Naffziger, San Francisco, president; Dr. Vernon C. David, Chicago, first vice president; Dr. Fraser B. Gurd, Montreal, second vice president. The 1938 class of initiates will be received into Fellowship at this session. Eminent surgeons of the United States and Canada and a number of visiting surgeons from foreign countries will present and discuss papers dealing with surgical subjects of timely importance at these sessions. Other features of the program for the Congress include a number of conferences and symposia dealing with fractures, cancer, obstetrics and gynecology, urology, neurosurgery, traumatic surgery, thoracic surgery, etc.

In addition to an extensive schedule of operative clinics and demonstrations at the hospitals and schools prepared by the subcommittees on ophthalmological and otolaryngological surgery, programs are being prepared for evening sessions for these sections on Tuesday and Thursday evenings at the Waldorf-Astoria Hotel, at which visiting ophthalmologists and otolaryngologists will present and discuss papers of special interest to those who practice these specialties.

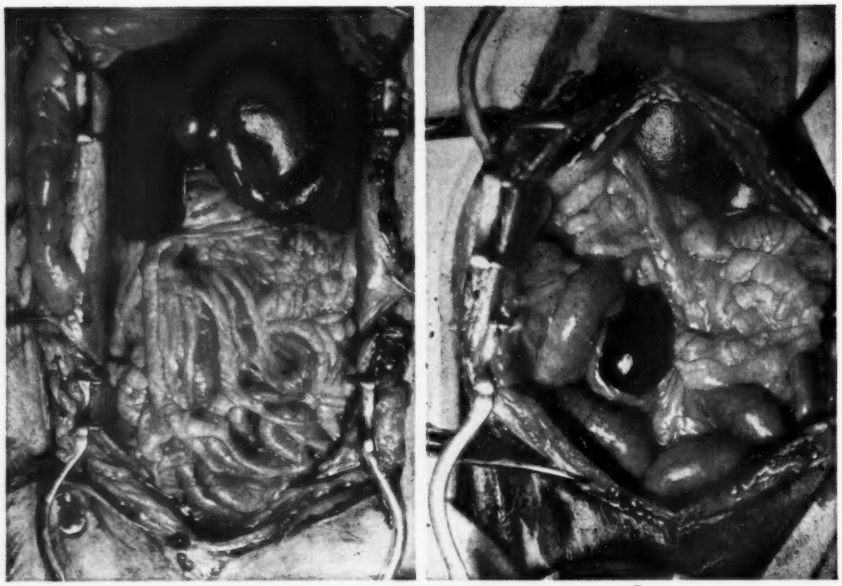
The annual hospital conference will open the Congress with a session in the Ball Room of the Waldorf-Astoria at 10 o'clock on Monday morning, at which a complete report on the college plan for graduate training in surgery will be presented. On Monday afternoon and on Tuesday, Wednesday and Thursday, both morning and afternoon, an interesting program of papers, round table conferences and practical demonstrations, dealing with many problems related to hospital efficiency is being prepared. It is planned to make this year's session of wide interest and practical character through a careful selection of subjects to be presented and discussed by surgeons and hospital executives, particular emphasis being directed toward professional standards and the vital problems related to hospital economics.

Headquarters for the Congress will be established at the Waldorf-Astoria Hotel, on Park Avenue between 49th and 50th Streets, where the Grand Ball Room and large adjacent foyers, the Astor Gallery, Jade and Basildon Rooms, all on the third floor of the hotel, have been reserved for Congress headquarters—for scientific sessions and conferences, and for the scientific and technical exhibits.

The technical exhibition, together with the registration and clinic ticket bureaus, will be located in the east foyer, Astor Gallery, Jade and Basildon Rooms, all on the third floor of the hotel. The bulletin boards, on which the daily clinical program will be posted each afternoon for the following day, will be placed in these rooms. Leading manufacturers of surgical instruments, x-ray apparatus, sterilizers, operating room lights, ligatures, dressings, hospital apparatus and supplies of all kinds, pharmaceuticals and publishers of medical books will be represented in this exhibition.

The hospitals and medical schools of Greater New York afford accommodation for a large number of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics. The limit of attendance will be based upon the result of a survey of the operating rooms and laboratories of the hospitals and medical schools, to determine their capacity for visitors. It is expected, therefore, that those surgeons who wish to attend the Congress will register in advance. A registration fee will be required of surgeons attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the Congress. To each surgeon registering in advance a formal receipt will be issued, which is to be exchanged for a general admission card upon his registration at headquarters during the Congress. This card is not transferable, and must be presented in order to secure clinic tickets and admission to scientific sessions. The registration fee for Fellows and endorsed junior candidates is $5.00, except that no fee will be required of local Fellows participating in the program and initiates of the class of 1938. For all others, invited as guests of the Clinical Congress, the fee will be $10.00.

Admittance to the clinics and demonstrations will be controlled by means of special clinic tickets, such plan providing an efficient means for the distribution of the visiting surgeons among the several clinics and insuring against overcrowding, the number of tickets issued for any one clinic being limited to the capacity of the room in which the clinic is given.



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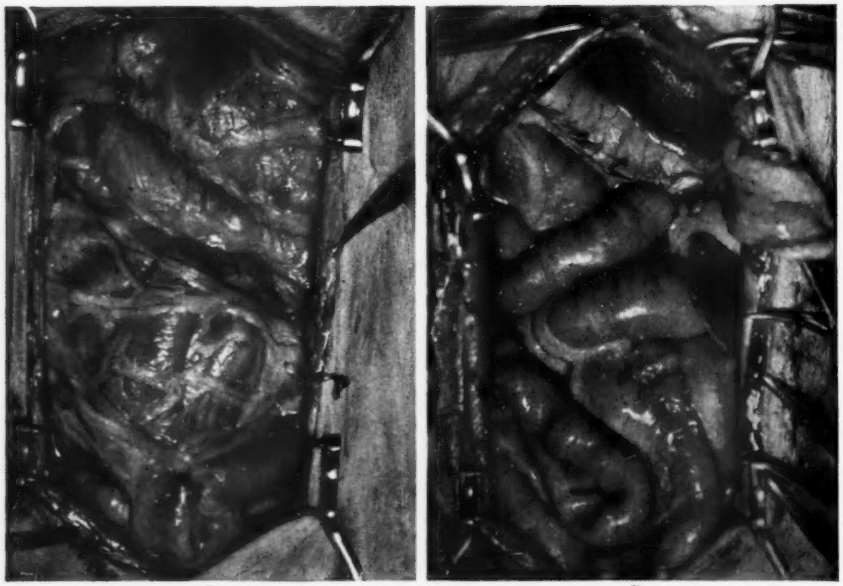

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PLATE I

Induced Spreading Peritonitis Complicating Acute Perforative Appendicitis
John O. Bower, M.D., F.A.C.S., John C. Burns, M.D., and Harold K. Mengle, M.D.

(See legends on opposite page.)